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PROFESSIONAL STATUS OF THE BIOLOGIST

ONE of the paradoxes of civilized life is the lowly position occupied among the sciences by the study of living things. There seems, in Great Britain at least, to be a general disposition to regard biology as something in the nature of a pastime, while the physicist and the chemist are held in respect as serious practitioners. Only in the treatment and, to a modest degree, the prevention of disease, and in agriculture, has biological science a recognized position. That the well-being of the human race is closely bound up with the ineludible facts of life, which together constitute the equilibrium of Nature, is not generally recognized.

It was, therefore, with special interest that we studied the presidential address of Sir Henry Tizard at the recent meeting in Brighton of the British Association, and especially his conclusion that "Whatever new comforts and luxuries may be provided in future by the advancement of physical science, it is on the development of the biological sciences that the peace and prosperity of the world will largely depend". With this view we are in hearty agreement, though we should prefer to substitute for the word "largely" the word "ultimately". Sir John Boyd Orr expounded a similar view when addressing the Summer School in 1942 of the British Social Hygiene Council held in Cambridge.

But, if biology is to play the part required of it, it must be recognized as a profession, not as a hobby. It must be placed on the same professional level as chemistry, physics, engineering and medicine, with a corresponding prestige. For this reason we welcome the announcement, referred to on p. 878, of the proposal to establish an Institute of Biology. The other sciences to which we have referred have their professional organisations competent to give advice on questions involving the training, employment and remuneration of its members. Biology has no such comprehensive organisation, and, in consequence, many of those who wish to be recognized as professional biologists are led to refer to their membership of one of the academic societies, which does not necessarily involve, and is commonly quite independent of, professional qualifications. A notorious example of this practice is the use of the letters F.Z.S., which has compelled the Council of the Zoological Society of London to introduce a rule requiring all candidates for election to sign a declaration that they agree not to use these letters in furtherance of business interests.

Apart from being of real benefit to the individual biologist, an Institute of Biology would be a valuable, indeed an essential, asset to Great Britain and the British Commonwealth. On biological progress depends much that is inherent in the plans for the development of the Colonies, for example. Young biologists who take their first posts abroad in a British Colony frequently find themselves cut off from important biological contacts. An Institute could help such men in many ways, and could keep

records of their service; then, in the event of their appointment being terminated for, say, political reasons (as has happened in India, Burma and Palestine), the Institute would be available for helping these men to find appointments elsewhere which are commensurate with their records, experience and qualifications.

It has been suggested that it may prove difficult to form an Institute of Biology because of the acute jealousies and antagonisms to which this field of science has appeared to give birth, and the consequent difficulty of persuading any group of biologists to agree on a common policy. It is to be hoped that such reasons will not adversely affect the final outcome; for it is quite clear that an Institute of Biology is badly needed in Britain. Moreover, coming from the Biological Council, the proposal presumably has the support of the leading biological societies and associations in Britain; these are listed at the end of the article already referred to. The founding of an Institute should be the main objective of all recognized biologists; its constitution, aims and objectives will have to be thrashed out around the conference table afterwards.

MICROWAVE TECHNIQUES

Microwave Transmission Circuits

Edited by George L. Ragan (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 9.) Pp. xvii+725. 51*s*.

Technique of Microwave Measurements

Edited by Assoc. Prof. Carol G. Montgomery. (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 11.) Pp. xix+939. 60*s*.

Microwave Duplexers

Edited by Louis D. Smullin and Assoc. Prof. Carol G. Montgomery. (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 14.) Pp. xiv+437. 39*s*.

Crystal Rectifiers

By Assoc. Prof. Henry C. Torrey and Assoc. Prof. Charles A. Whitmer. Edited by S. A. Goudsmit, James L. Lawson, Leon B. Linford and Albert M. Stone. (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 15.) Pp. xiii+443. 36*s*.

Microwave Mixers

By Robert V. Pound; with a Chapter by Eric Durand. Edited by C. G. Montgomery and D. D. Montgomery. (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 16.) Pp. xii+381. 33*s*.

Microwave Receivers

Edited by Assoc. Prof. S. N. Van Voorhis. (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 23.) Pp. xviii+618. 48*s*.

(New York and London: McGraw-Hill Book Co., Inc., 1947–48.)

As readers of these columns will be aware, workers in the Radiation Laboratory of the Massachusetts Institute of Technology are producing a series of books on microwave techniques which, when complete, will contain twenty-eight volumes, one of which is to be an index of the whole series. Reviews of several books of the series have already appeared in *Nature*, and the present notice deals with a further six volumes, namely, numbers 9, 11, 14, 15, 16 and 23.

According to the general foreword to the series, the aim has been to make widely available, as soon as security regulations permitted, the results of the enormous research and development effort on radar and related techniques which took place during the Second World War. It is further stated that: "The work described is the collective result of work done at many laboratories, Army, Navy, university, and industrial, both in this country [that is, United States of America] and in England, Canada and other Dominions".

It would be easy to criticize each one of these volumes in detail, and to point out faults here and there in matters of presentation, to suggest that some things might have been better said and that some might with advantage have been left out, or that there is an unnecessary amount of duplication of material between volumes. Nevertheless, if all this were done, one must still be full of admiration for the manner in which such a great task has been accomplished in so short a time, and, with all its faults, on the whole so successfully. It might also be said that some of the techniques described are already out of date; but that is inevitable in a subject which has developed as rapidly as has the study of microwave phenomena in the past few years. It must be said, however, that despite the statement in the foreword, most of the work described in detail is of American origin, and that, with a few notable exceptions, references to British work are infrequent. This is probably not due to any ulterior motive on the part of the various authors, but simply arises from the fact that much British material which might, and could otherwise, have been used had not been 'declassified', and so was not available for reproduction at the time these books were written.

The duplication of a certain amount of subject-matter in several volumes is perhaps inevitable since the whole field has been split up into so many parts, and some of these naturally overlap. On the other hand, in reading any given volume one may occasionally be aware of certain gaps in the presentation, for, in the process of the development of each book, subjects more properly dealt with in one of the companion volumes are touched upon. A certain amount of cross-reference from volume to volume is therefore necessary; if this were not to be expected the degree of duplication would become even more marked.

Volume 9, entitled "Microwave Transmission Circuits", is concerned with the problem of the transmission of power at microwave frequencies from one place to another. In the course of some 700 pages many aspects of this problem are dealt with in very great detail. Most of the designs described in these pages were developed in the war-time Radiation Laboratory of the Massachusetts Institute of Technology, though workers in this field in Great Britain will recognize many features which could just as well have been described as originating here. In the first two chapters a discussion of conventional transmission-line theory leads to a treatment of the guided wave concept, and of the more common types of wave-guide. There then follow chapters dealing with such subjects as materials and construction techniques, rigid and flexible coaxial lines and wave-

guides, coupling units and rotary joints in transmission systems. Tuners, power dividers and switches are described in Chapter 8. The last two chapters, 9 and 10, are devoted to a discussion of microwave filters, the first from a theoretical and the second from a design point of view. The principles of filter theory put forward here are not merely extensions to microwave frequencies of principles already in use at lower frequencies; they represent rather a significant contribution to the subject along entirely new lines, and the results should find many useful applications in the design of filters for low frequencies.

Many readers will probably find Volume 11, on the "Technique of Microwave Measurements", one of the most valuable in the series, in that it contains much that will continue to be of great use over the whole field of microwave applications in the future. Throughout the book, in the consideration of the design and construction of equipment for microwave measurements, one is continually reminded that it is here necessary to think in terms of the electromagnetic field rather than in terms of current and voltage, the usual practice at lower frequencies. The volume is divided into four main parts in which are described power generation and measurement, wavelength and frequency measurements, the measurement of impedance and standing waves, and finally attenuation and radiation measurement. There are fifteen chapters, and the topics treated in detail include microwave oscillators and devices by means of which their frequency may be stabilized, measurement of radiofrequency power at low, medium and high levels, and the design of signal generators and noise sources. In Part 2 the use of wave-guides and cavity resonators in the measurement of wave-length and frequency is described, and also the determination of pulse shape and associated frequency spectrum. Part 3 contains a description of the measurement of standing waves and the use of various types of impedance bridge. Part 3 further includes a long and interesting chapter (Chapter 10) in which methods of determining dielectric constants are discussed, and one is pleased to note here considerable reference to British work. The final part of this volume (Chapters 11–15) deals with the construction of such items of apparatus as microwave attenuators, both of the wave-guide 'cut-off' and resistive types, and directional couplers. There are also chapters on the measurement of attenuation and on radiofrequency phase and pattern determinations.

"Microwave Duplexers", Volume 14, is of rather more specialized interest than the two books discussed above. It is concerned largely with the design and behaviour of switching devices which enable a common aerial system to be used for a high-power transmitter and a receiver, and which are therefore of fundamental importance in the construction of radar sets. The characteristics of these switches at both low- and high-power levels are discussed, the high-power level operation being dealt with in considerable detail; and the properties of various gases which are used in the switches are described. The final chapter (9) includes a description of techniques whereby a measurement of the performance of the switches, as well as of the duplexer as a whole, may be made. These special switches were a war-time development, and naturally the only thing of importance at that time was that they should work; much of the knowledge we have of them is still of an empirical nature. Chapter 5 is, however, devoted to a theoretical treatment of the gaseous discharge at very high frequencies. This is admittedly a most difficult subject—our understanding of the phenomenon even at lower frequencies is still incomplete—but the author presents much that is known in a very satisfactory manner.

"Crystal Rectifiers" is the title of Volume 15, and in this book we see how an early radio component, which has been but little used since the invention of the thermionic valve several decades ago, has once again become an important element in microwave equipment. The crystal rectifier is now compact and stable, and is superior to the thermionic diode in many applications. Its most extensive use so far in the new field has been as a frequency converter in microwave receivers, where its performance is unequalled, and also as a low-level detector. Volume 15 is divided into three main parts, the first of which deals with the general fundamental properties of the crystal rectifier, and in Chapters 3 and 4 we have an extensive treatment of the theory of semi-conductors and point-contact rectifiers. These two chapters include a discussion of such subjects as electron distribution in semi-conductors, work functions and contact potentials, conductivity and Hall coefficients, barrier-layer rectification, formation and structure of the barrier layer, depletion layers and rectification at very high frequencies. It is well known that the theory of many of these phenomena is as yet far from complete, and no attempt is made to disguise this fact in the present treatise or to gloss over experimental results which are not in accordance with the theory as it now stands. Part 2, comprising Chapters 5–10, deals with the crystal as a frequency converter and continues with a discussion of noise generation in crystals, of loss and noise measurements, of the theory and experimental information on the burn-out of crystals, test equipment for the measurement of conversion-loss and noise, and finally manufacturing techniques. All the examples given, and nearly all the manufacturing processes quoted, are American. 'Special types' are described in Part 3 (Chapters 11–13). The properties of crystal rectifiers used for detection at low power-levels are considered in Chapter 11, while Chapters 12 and 13 are concerned with a study of high-inverse-voltage rectifiers and welded-contact germanium crystals. Many would probably say that some of the types discussed should no longer be regarded as 'special'.

The volume on "Microwave Mixers" (No. 16) necessarily duplicates a certain amount of the material of Volume 15, since it deals mainly with the use of the crystal as a frequency converter in superheterodyne radar receivers. After an introductory chapter, therefore, in which there is a classification and description of types of microwave receiver, and Chapter 2, which contains a treatment of the physical characteristics of crystals and of network equivalences for crystal mixers, the emphasis in the succeeding chapters is almost entirely on the design and construction of mixer circuits and on allied problems. Simple microwave crystal mixers for the centimetre-wave band are described in Chapter 3, and multiple-function mixers in Chapter 4. Then follow chapters on local-oscillator noise and on balanced mixers, including some discussion on the characteristics and uses of the 'Magic-T'. Chapter 7 contains a description of various types of frequency-control circuit, and the last chapter (8) deals with special measurement techniques for such properties as noise-figure and admittance loss of mixers.

The subject-matter of Volume 23 is "Microwave Receivers". Here again we find a certain amount of duplication, particularly with Volumes 14 and 16, since duplexers and mixers are naturally associated with receivers, but it is not so extensive as to prove irksome. One might, however, have expected a more logical arrangement of the subjects treated in the early chapters. Duplexers, microwave mixers and local-oscillators are dealt with briefly in Chapter 2—local-oscillators, in fact, too much so. Chapters 3, 4, 5 and 6 are concerned with automatic frequency-control systems, intermediate-frequency input circuits, very high frequency amplifiers, mixers and oscillators, and intermediate-frequency amplifiers respectively. Second detectors are described in Chapter 7, video-amplifiers in Chapter 8 and gain control circuits in Chapter 9. There are then three chapters on the mechanical construction of receivers, radiofrequency and intermediate-frequency test equipment. Chapters 13–17 give details of the design and construction of several specific receivers, including an airborne centimetre wave-length type, an automatic tracking radar, a two-band 200 Mc./s. superheterodyne receiver and a wide-band frequency-modulation receiver. In the last four chapters, 18–21, there is a more general discussion of beacon superheterodyne receivers, crystal-video receivers, superregenerative receivers and, finally, moving-target indication systems. It might, perhaps, have been better to sacrifice a little of the extensive detailed treatment of the intermediate- and video-frequency circuits for a rather more comprehensive account of the radiofrequency aspect of the problem, since this seems to have been passed over all too briefly. Of the six volumes here discussed the present reviewer found this one perhaps the least satisfactory in the matter of general presentation and balance of subject-matter.

There are remarkably few typographical errors in all of these volumes despite the conditions of speed under which they must have been prepared. They are all further characterized by a great wealth of circuit diagrams, line drawings and, in many instances, by photographs of equipment. These features will be welcomed by, and will be of great value to, anyone wishing to design and construct microwave equipment, and to such—or indeed anyone interested in microwave techniques—these books may certainly be recommended.

J. A. Saxton

POPULAR BOTANY

The Growing Plant

By Prof. W. Neilson-Jones. Pp. 206+8 plates. (London: Faber and Faber, Ltd., 1948.) 16s. net.

THE popularization of science has become an important social activity. Unesco holds conferences on how it should be done; and the Russians have a special government department to manage it in the Soviet Union. The public demand for it is sufficient to support numerous books on popular science, and recurrent publications such as *Science News* and *New Biology*. Already the difference between books on science and books on popular science has become indistinct: there is continuous variation, from the monograph by a specialist for a few specialists, to the article by a journalist for a million newspaper readers. There is an increasingly important demand for books lying between these two extremes, for the reader who knows some science already. This sort of reader is not easy to satisfy. He does not want catalogues of 'wonders of Nature'; he is annoyed if he is mystified; and he demands a high standard of accuracy. The journalist who has 'cashed in' on the popularity of science cannot write popular science at this level; it must be done by a professional scientific worker, and it is exasperatingly difficult.

Prof. W. Neilson-Jones is to be congratulated on having written a book which will go a long way toward satisfying the reader who is already familiar with some science. His book is (as one would expect) accurate, though many botanists will disagree with some of his views on vernalization and photoperiodism. It is written in an easy (though occasionally ambiguous) style, with a pleasant dry wit. It is a series of independent essays on some aspects of botany which are not treated well in elementary text-books: the plant as informant, chimæras, plant hormones, the control of flowering, plant nutrition, and the story of the soil. The book contains much of what our grandfathers called 'curious information': the difficulties in making floral clocks, the use of tomatoes to locate escaping gas, the occurrence of daisies on prehistoric trackways, and so on. However, the author does not try to impress the reader by means of staggering statistics or arresting adjectives, and he draws his examples from a life-time of experience and thought.

On the dust cover it is said that the book is for the general reader; but it would be unfair on the book to judge it by this criterion. It is rather an anthology of what a botanist thinks will interest other scientific workers. He would be a hardy general reader who could read comfortably that "the fully oxidised tetravalent form of manganese" is not available to plants, and that "no plastids from the pollen grains are brought into the egg cell at fertilization". However, as a book for the science master, the chemist whose hobby is gardening, the horticulturist, the first-year student, the reader (in brief) of *New Biology* and *Science News*, "The Growing Plant" can be recommended with confidence. The book is well produced and well illustrated, although there is an unaccountable transposition of words on page 19.

E. Ashby

CONGRESS OF BIOLOGICAL CHEMISTRY

Un symposium sur les proteines

Par A. Tiselius, D. P. Riley, E. Gorter, D. G. Dervichian, M. Joly, J. Brachet, P. Rebuffat, R. Vendrely, C. Wunderly, V. Desreux, H. Dieu, M. Dubuisson, J. Jacob, E. J. Bigwood, M. Jutisz, E. Lederer, G. Hamoir, P. Desnuelle, M. Rovery et M. Errera. (Médecine et biologie, Monographies publiées sous la direction de Marcel Florkin, No. 5.) Pp. 284. (Liége: Éditions Desoer; Paris: Masson et Cie., 1947.) 165 francs.

THE Seventh Congress of Biological Chemistry was held at Liège in October 1946. It was thus the first large international gathering of biochemists to be held in Europe after the War. The collection of seventeen papers, contributed to the general discussion on proteins, has now been published under the title "Un symposium sur les proteines". It is of

particular interest to the general reader in chemistry and biochemistry since it reveals trends of thought that are forming the background for the present remarkable developments in experimental technique.

The subject-matter of the opening paper by A. Tiselius was happily chosen in that it served as a logical introduction to many of the later contributions to the discussion. Prof. Tiselius dealt with the general strategy of the attack on a problem that has long intrigued chemists, biochemists and physicists interested in proteins, namely, that of the detailed orientation of the amino-acid residues in the protein molecule. The logical way of attacking this problem is by a process of successive fragmentation of the protein chain. If large fragments could be isolated, they could again be broken up into smaller fragments, the constitution of which could be determined by methods already available. The problem is, of course, mainly one of technique, but, as further contributions to the discussion showed, a rich field is developing in the isolation, determination and synthesis of oligopeptides and polypeptides; and although it may be too much to hope that the complete constitution of a natural protein will be determined in the near future, it is clear that a concerted attack on these lines by the many workers already engaged would yield an understanding of the main features of protein structure.

Another important aspect of the problem is the study of the natural protein molecule as a whole, since it is clear that no real advance can be made by the method of successive degradation until adequate proof is available that the protein is, in fact, a single molecular species. The importance of this point is now well appreciated, and the newer physical and chemical methods are increasingly employed in the search for protein preparations of proved molecular homogeneity. This search is proving more difficult and more prolonged than was at one time expected, and several of the papers, reporting studies of proteins by use of X-ray diffraction, electrophoresis, and the spreading of layers on water, emphasized the extreme complexity concealed by the terms 'albumin' and 'globulin'.

THE MIND OF THE CHILD

Childhood and After

Some Essays and Clinical Studies. By Dr. Susan Isaacs. Pp. viii+245. (London: Routledge and Kegan Paul, Ltd., 1948.) 15*s*. net.

THIS volume of selected papers, nearly all of which have already appeared in journal form, furnishes a representative sample of the late Mrs. Isaacs' contributions to the theory and practice of child psychology during the past twenty years [see p. 881]. The contents comprise five papers dealing with general aspects of child welfare and eight of a more specialized nature devoted to problems in the field of psycho-analysis. The general papers include a competent review of recent advances in the psychology of young children, an essay on the mental hygiene of the pre-school child and a discussion of the educational value of the nursery school. Included also is a report dealing with the question of children in institutions, originally presented as a memorandum to the Home Office Care of Children Committee in 1945 and here printed in full for the first time. Although some may feel that the arguments advanced in this report are based on a somewhat selective consideration of the evidence, their cogency can be denied by none who has to do with the institutional care of young children. The memorandum is a model of lucid presentation and persuasive discussion of a difficult problem.

The eight technical papers which make up the bulk of the volume will probably prove of greater interest to the scientific reader. Four deal with theoretical aspects of psycho-analysis and four with special aspects of child development considered from the psycho-analytic point of view. Much of the material discussed may appear bizarre, if not wholly improbable, to the reader unversed in Freudian psychology. It must, however, be borne in mind that the evidence in favour of what Freud called (rather misleadingly) infantile sexuality is nowadays extremely impressive. Although there is disagreement on points of detail, the broad principle of early psycho-sexual development is accepted by a great many psychologists outside the Freudian fold. This principle not only renders comprehensible a wide variety of psychoneurotic manifestations but also contributes in an important way to our understanding of the normal processes involved in the formation of character. One must, therefore, expect of the reader at least some understanding of the Freudian position if he is to follow the arguments developed in these papers. If he remains unconvinced of its basic validity, he would do better to turn to Freud's original writings than to persevere with a book such as this.

A striking impression which is left on the reader of these papers is the virtual impossibility of understanding the mind of the child in terms of adult psychology. Although we have long outgrown anthropomorphism in the biological field, something very like it appears to cling to us in our conceptions of the child's mentality. From the work of Mrs. Isaacs and other child analysts, we realize the futility of attempting to interpret the mind of the young child in terms of the attitudes and beliefs of adult life. The mind of the child, it appears, is a mind in which impulses of a primitive nature give rise to a wealth of phantasies, in part unconscious, which are apt to mingle freely with the world of sense perception. In this phantasy world, figures derived from the parents acquire qualities of beneficence or punitiveness out of all proportion to the child's actual experience. These phantasies not only influence the child's acquisition of conscience and character but also may lie behind a variety of psycho-neurotic manifestations. Their significance in relation to aggression and guilt, 'temper tantrums' and anxiety, is well brought out by Mrs. Isaacs in her clinical studies.

It must be mentioned that the author of this book, in common with so many protagonists of psychoanalysis, pays scant respect to the constitutional factor in neurotic illness. Although Freud himself admitted that all neurosis is at bottom a constitutional affair, this aspect is constantly neglected in neo-Freudian psychopathology. In this connexion, the medical reader will not be slow to note that several of Mrs. Isaacs' patients displayed pre-psychotic manifestations. The latter surely betray a constitutional element which cannot be neglected in theoretical interpretation. One might suggest that until the organic basis of psycho-neurotic illness is more fully considered by psycho-analysts, much of their doctrine will remain, in Freud's words, ". . . but a superstructure which will have to be set on its organic foundation".

O. L. ZANGWILL

ROYAL SOCIETY

ANNIVERSARY ADDRESS BY SIR ROBERT ROBINSON, F.R.S.

ON behalf of the Fellows of the Royal Society the following telegram was sent on November 16 to His Majesty the King: "Your loyal and dutiful subjects the President, Council and Fellows of the Royal Society of London beg leave to offer our respectful and sincere felicitations on the birth of the Prince".

A message was also sent to Her Royal Highness the Princess Elizabeth, as follows: "The President, Council and Fellows of the Royal Society of London send their respectful and sincere congratulations to Your Royal Highness on the happy event of the birth of the Prince".

We have received gracious acknowledgments in the following terms: "Please convey to the Council and Fellows of the Royal Society the sincere thanks of the Queen and myself for their kind message on the birth of our grandchild.

"GEORGE R."

"We are most grateful for your kind message of congratulations.

"ELIZABETH AND PHILIP"

AWARD OF MEDALS, 1948

Copley Medal

The COPLEY MEDAL is awarded to Prof. Archibald Vivian Hill, for his outstanding contributions to the physiology of muscular processes.

Towards the end of the nineteenth century physiologists discerned a field of investigation in the physical and chemical phenomena involved in the characteristic activity of muscle and nerve; but the questions propounded could receive no satisfactory answers, chiefly owing to the lack of adequate methods. Hill, during the last thirty-five years, has applied profound mathematical skill and a flair for the design and management of delicate instruments to the provision of a sound basis for experimental and theoretical advance. In his hands the thermopile was developed into an instrument of great precision and delicacy, and conditions for its use in relation to the material studied were established so as to provide significant results.

The work on heat production in muscle has led to a picture within a framework which can accommodate many contemporary biochemical studies in a harmonious fashion. Attention has constantly been paid to ensuring the thermodynamic soundness of the systems suggested. Moreover, he was able to exploit some of his findings on isolated muscle in the course of a study of the dynamics of muscular contraction in the living body, including that in the human subject.

A natural extension of Hill's researches has enabled him to contribute notably to our knowledge of the heat-production and excitability of nerve. Previous workers failed to detect any heat-production in nerve tissues, but Hill demonstrated the definite thermal changes that are associated with the passage of impulses. These were found to be so small that no one-way contemporary chemical reaction could account for them. It would be necessary to postulate reversible changes which proceed in both directions. This was a main factor in the elaboration of the modern view that the nerve impulse results in an altered state of polarization of the essential surface membranes. The heat change which occurs after the passage of the impulses was found to be small but definite, and was related to the energy expended in the recovery of the membrane.

Hill has made contributions of great distinction in other fields, and among other topics investigated by him is that of the physical chemistry of the oxy-haemoglobin equilibrium in the blood.

Hill has been a source of inspiration to many pupils, collaborators and colleagues, and has founded a school of research. His eminent services to physiology have been possible as the result of a happy combination of wide basic knowledge of the physical sciences, unusual skill in the design and execution of experiments, a philosophic outlook, and above all the curiosity and ambition to attack some of the most difficult problems in biophysics and biochemistry.

Rumford Medal

The RUMFORD MEDAL is awarded to Prof. Franz Eugen Simon for his distinguished researches on the properties of matter at low temperatures.

The school of low-temperature physics which Simon has created at Oxford is one of the leading centres of such research in the world and has achieved highly important results in the spheres of both theory and practice.

His great knowledge of thermodynamics was brought into service in the development of extremely simple methods for reaching the temperatures of liquid helium in the laboratory. He realized that at low temperatures adiabatic expansion of helium compressed into a small reservoir would absorb sufficient heat to liquefy the bulk of the gas and to cool the container and specimens under examination to liquid helium temperatures. Thus, provided reasonable supplies of liquid air are available, it becomes possible for any laboratory to carry out investigations at the lowest attainable temperatures with equipment which is inexpensive and simple to operate. Many other contributions to technique in this field have been made by Simon and his co-workers.

With the aid of these new or improved methods many interesting observations, with a bearing on fundamental knowledge, have been made. Outstanding problems in superconductivity, especially the part played by impurities, have been solved and the 'freezing out' of magnetic flux has been explained. The peculiar properties of liquid helium II and the transition to this state have been investigated intensively. The thermodynamics of the approach to absolute zero has been stated very clearly by Simon, and progress has been made in new methods for reaching this temperature. More recently, extended equipment has facilitated the study of the properties of atomic nuclei oriented in magnetic fields.

Simon has made significant contributions to the elaboration of devices for the separation of isotopes and to the design of plants in which thermodynamic considerations are of predominating importance.

He has aptly illustrated the thesis that, in the world of modern physics, discovery and the progress of theory follow surely on the introduction of new and powerful tools of research.

Royal Medals

A ROYAL MEDAL is awarded to Prof. Harold Jeffreys for his fundamental investigations in theoretical geomechanics.

Much of Jeffreys' well-known book "The Earth" (1924, 1929) is based on his own work, and this is especially true of the section on near earthquakes. However, the book owes its unique position not only to these original contributions, but also to the skill and insight shown in the building up of a self-consistent picture of the earth from the very diverse and apparently contradictory materials available at the time when it was written. Its great influence has been due to the width of interest and the critical skill as well as to the depth of learning of its author.

During the thirties Jeffreys' main interest was in seismology. In a series of papers he has discussed the available observations in detail and reduced the errors in the seismological time-tables by a factor of 10 or more. This work has had an important effect on our knowledge of the earth's interior and has yielded numerical information of surprising accuracy, and, for example, the radius of the earth's central core is now known with an accuracy of a few kilometres.

Some of his early papers and the book "Scientific Inference" show an interest in the philosophical basis of the scientific method and in the theory of errors. This was intensified by the difficulties he met in adequately treating the seismological travel times, to which orthodox 'least square' methods are inapplicable. The discussion of these observations led to a series of papers on significance tests, and, finally, to a book, "The Theory of Probability", in which he discusses *de novo* the whole problem of the relation between observation and 'physical quantities'. The departures from orthodoxy have not proved universally acceptable, but it is generally agreed that Jeffreys has made an important contribution to a subject on which the last word has not yet been said.

Other topics to which Jeffreys has made material contributions are pure mathematics, the origin of the moon, the constitution of the planets, hydro- and aerodynamics. In particular, he gave the first mathematical discussion of the theory of aerofoils of finite thickness.

Other less relevant examples of the catholic interests of the Plumian professor of astronomy and natural philosophy could be cited. Whether as a specialized applied mathematician or as a teacher and leader of research, the eminent services he has rendered are most widely recognized.

A ROYAL MEDAL is awarded to Prof. James Gray for his distinguished work on the mechanism of posture and locomotion in vertebrate and other animals.

In 1933 Gray, by the use of cinematography, analysed the forces involved in the progression and turning of fish with long and short bodies. The inquiry reached its full development during the last ten years with the extension of these studies to vertebrates generally. In 1936 he discussed the swimming of dolphins; raising the hydrodynamical problem of the type of water flow past an undulating body. Later he analysed the locomotion of Amphibia and of snakes. The results of this part of the work led to a discussion of the mechanics of the tetrapod skeleton which was fundamental and placed an important part of the comparative anatomy of vertebrate animals on a functional basis for the first time. His work shows that the whole body of a tetrapod must be considered as a single functional unit; changes in the tension of one muscle being accompanied by a demonstrable pattern of changes in other muscles. Gray analysed and described the mechanical problems solved by tetrapods standing and moving over ground of varying slope and smoothness; he has also analysed the neuro-muscular phenomena responsible for the evident co-ordination of action. He showed the importance of peripheral reflexes in the initiation and maintenance of swimming movements in fish. This led him to the problem of the origin of locomotory patterns. His experiments on the neuromuscular system of annelids showed the major importance of patterns of peripheral stimuli.

This work, summarized in a Croonian Lecture, was later greatly extended by demonstration of the importance of peripheral reflexes in the locomotor activities of toads. It was found that there was no positive evidence for the existence of central rhythm in these animals, while, on the other hand, the proprioceptive reflexes arising from the muscles provide an adequate basis for locomotor action.

Gray's work is responsible for an important change in the direction of research in the comparative anatomy of vertebrates. Before its appearance, skeletal structure was examined in extraordinary detail and yet little or no attention was paid to musculature and to the relation of structure to the whole system in action. More than any other, Gray has shown that comparative anatomy is certainly not a dead science.

Davy Medal

The DAVY MEDAL is awarded to Prof. Edmund Langley Hirst for his distinguished contributions to the chemistry of carbohydrates.

The first demonstration of the six-membered ring structure of an aldose derivative was offered by Hirst and Purves in their study of methylxyloside, which was published in 1923. Since then, in collaboration with Sir Norman Haworth over a number of years, and independently, Hirst has played a great part in the establishment of fundamentals in the field of carbohydrate structure. His prolific experimentation is characterized by the highest accuracy and has afforded conclusive answers to many questions of importance.

Of his joint work in the Birmingham School the following must be cited: the recognition of pyranose and furanose forms of the simple sugars, the isolation of a crystalline furanoside for the first time, and the determination of the constitution of sucrose and other disaccharides.

His independent work on optical rotatory dispersion in the carbohydrate derivatives introduced new methods of attack on constitutional problems, which were of immense service in his later work on the constitution of vitamin C. In that investigation of outstanding merit he determined the structure of ascorbic acid and studied a large number of related products. In 1933 he shared in the synthesis of ascorbic acid and in the study of the physiological activity of the synthetic vitamin.

His researches on the polysaccharides have been conspicuously successful over a wide field, and largely

because of his development of new methods of end-group assay in the determination of structure. He has applied these methods successfully to starch, glycogen, and other polysaccharides, and to him we owe many advances in our knowledge of the nature of alginic acid, the plant gums and pectic substances.

The regularities and irregularities that have been disclosed have been of equal interest and unexpectedness.

Hirst has been a pioneer in unravelling the complexities of carbohydrate architecture, and to him must be attributed much of our present knowledge of this group of such great biological significance.

Darwin Medal

The DARWIN MEDAL is awarded to Prof. Ronald Aylmer Fisher for his distinguished contributions to the study of biological evolution.

A general principle that is consistently developed in Prof. Fisher's writings is that the course of evolution is not controlled by mutation but by selection operating upon the heritable variability which Mendelian recombination supplies.

In 1928 he was the first to suggest that dominance is the product of selection operating in the gene-complex of the organism. This theory he tested and confirmed experimentally with domestic poultry and later with mice.

The implications of his concept extend beyond the dominance phenomena, and underlie the whole theory of the modification of genic effects through selection acting on the gene-complex. This enables a character, even when under unifactorial control, to be adjusted to the needs of the organism. To Darwin, selection was a mechanism for rejecting the bad and conserving the good; it is largely to Fisher that we owe the view that it may mitigate the bad and enhance the good effects of the hereditary units.

The studies of Fisher on abundance and variability, the first of them undertaken in collaboration, have provided means for proving in general terms the proposition, implicit in the modern concept of evolution, that genes having minute favourable effects are in process of being spread through populations and are bringing about evolutionary change at the present time.

Fisher's methods of population analysis, developed from 1930 onwards, have made it possible to study the numerical aspect of animal communities with an exactitude previously unattainable.

The special opportunities for evolutionary study presented by polymorphism have always attracted Fisher, and he has repeatedly analysed the balance of selective agencies which may be involved. This point of view is apparent in his extensive work on human serology. He has also studied a polymorphism which had especially interested Darwin, that of the heterostyled plants, and he has extended the subject to elaborate the general theory of crossing-over in polyploids—a pioneer work of wide application.

Fisher's great contributions to statistics and to experimental design have provided tools now deemed essential to the quantitative biologist. But they are fundamental also to the experimental studies of evolution which have become so important a feature of modern biological research.

Hughes Medal

The HUGHES MEDAL is awarded to Sir Robert Watson-Watt for his pioneer researches in radio-telegraphy.

Watson-Watt has been a leader in the field of radio research since the early nineteen twenties. He began to work on the subject of atmospherics in 1915, paying attention at first to the subject of the direction of arrival. He published the first English studies on this subject, establishing the 'cum-solar' swing of the place of origin throughout the day. He developed the cathode-ray direction-finder as a means for finding the direction of arrival of individual atmospherics. This has proved of immense value in the location of thunderstorms during the War. With a number of collaborators he later studied the wave-form of atmospherics.

He has been the leading exponent of the use of the cathode-ray oscillograph for a great variety of purposes in physical research.

Watson-Watt was the leader of the earliest British work on radar, or radiolocation, as it was then called. Although the basic principles were known, enormous technical difficulties had to be overcome before radar could be developed in the form of an operational instrument. That these difficulties were, in fact, overcome was due, in Great Britain, more to Sir Robert Watson-Watt than to any other man. He is now turning with equal insistence to the peace-time applications of radar, especially in the service of civil aviation.

New Officers

Sir Alfred Egerton now lays down his office as Physical Secretary of the Society. During the past ten years he has shown a deep concern for the Society's welfare, and the utmost willingness to undertake onerous duties.

I would like to remind you of some of his many activities. In the early days of 1939 he was chiefly instrumental in the creation of a Central Register of Scientists. The significance of this action by the Society was by no means exhausted by the end of hostilities. Almost in the first month of the War he took a leading part in persuading the War Cabinet to set up a Scientific Advisory Committee. These efforts, after initial setbacks, succeeded in October 1940, and the Committee functioned usefully during the war period and was the forerunner of the present Advisory Committee on Scientific Policy. I cannot deal at length with his services in a more personal capacity, for example, to the Ministry of Fuel and Power, but we recall with gratitude his interest in the re-organisation of the Gassiot Committee and in the survey, which the Society conducted, of the needs of fundamental science after the War. He has been an ever-welcome guest overseas, and has a distinguished record as an ambassador of science. His great services to the Empire Scientific Conference of 1946 and its offspring, the Scientific Information Conference of the present year, are fresh in our memory. He worked zealously, carefully and effectively—an unusual and difficult combination—and the results will benefit every part of the Commonwealth in which scientific activity exists.

Sir Alfred will continue to act as virtual representative of the Society in several important capacities; if I may mention just one as an example, it may be as a member of the Scientific Advisory Council for the Festival of Britain, 1951.

We shall not be able to take so much advantage of his habitual generosity as in the past, but, in case of need, we shall certainly seek his help and advice.

Prof. David Brunt has been elected as the Physical Secretary of the Society. To him we offer the most

cordial welcome and good wishes, coupled with thanks for his willingness to assume the duties and responsibilities of the office.

One of the most valuable of the traditions of the Society is our claim to exercise initiative when the circumstances suggest a new departure. So far as I am aware it has not previously been thought desirable to designate any person as honorary librarian to the Society; but the Council felt that the present chairman of the Library Committee had given services which were probably without precedent. Prof. E. N. da C. Andrade's knowledge of the older scientific literature is unrivalled, and has been freely available to the great advantage of the Society.

The retirement of Mr. H. W. Robinson as librarian occurred at the end of March of this year. He joined the staff in 1902 and assisted the chief clerk and the librarian; in 1910 he became library assistant and in 1930 assistant librarian. He has been librarian since 1935. His work for the Society and its Library has been invaluable, and we may recall with special gratitude the care he showed in the safe bestowal of our treasures in the time of danger. An earnest student of the history of science, he has paid special attention to the study of Robert Hooke, on whose life and work he is a recognized authority. In expressing our gratitude for his devoted labours, we note with pleasure that Mr. Robinson will continue to assist Prof. Turnbull in editing the Newton letters.

Scientific Information

The outstanding event of the past year in connexion with the Society has been the Scientific Information Conference. We welcomed delegates from the countries of the Commonwealth and also from the National Academy of Sciences of the United States, and from Unesco. It can thus be claimed that the whole of the English-speaking scientific world was well represented. More than half of all scientific literature is written in English, and in making such a comprehensive review of scientific information services, I think the Society may be judged to have taken a timely initiative. We were gratified by the interest shown by Fellows and the time and energy so freely given by them to ensure the success of the Conference.

The Council of the Royal Society received from the Conference many recommendations dealing with the publication of papers reporting original work, abstracting services, reviews and annual reports, library services, classification and indexing, and other relevant matters. It has been decided to implement these, so far as proves possible, with the aid of a Treasury grant, and for this purpose the Council has set up an Information Services Committee, which has just held its first meeting. I believe that an energetic follow-up of the recommendations will result in real progress. The value of the Conference itself, irrespective of these recommendations, should not be under-estimated. Divergent points of view were advocated, and many of the difficulties besetting the free and rapid communication of new knowledge were at least recognized as the result of discussion and, in many cases, were removed. The problem is a complex one, and its solution demands both due regard for traditional methods and an acute appreciation of novel techniques.

Having given this lead, the Society will now be expected to play an increasingly important part, nationally and internationally, in improving scientific information services.

It is doubtful whether the general progress of science has ever been more impressive than at the present time, and this fact emphasizes the importance of adequate outlets for the publication of the great volume of original work that is being poured out. Formidable archives are undoubtedly accumulating. To meet the demand many new journals have been founded, and here is a short list of them. *Agricultural Chemicals*, Baltimore, 1946; *British Journal of Pharmacology and Chemotherapy*, U.K., 1946; *Hungarica Acta Chimica*, Budapest, 1946; *Journal of Colloid Science*, N.Y., 1946; *Journal of Polymer Science*, N.Y., started publishing 1946; *Zeitschrift für Naturforschung*, Wiesbaden, 1946; *Acta Chemica Scandinavica*, 1947, Chemical Societies of Denmark, Finland, Norway and Sweden; *Analytica Chemica Acta*, N.Y., 1947; *Biochemica et Biophysica Acta*, N.Y.; *Die Makromolekulare Chemie*, Basle, 1947; *Food Technology*, N.Y., 1947; *Heredity*, London, 1947; *Journal of Glaciology*, U.K., 1947; *Nucleonics*, N.Y., 1947; *Acta Crystallographica*, U.K., 1948; *Acta Physica Austriaca*, Vienna, 1948; *Annali di Geofisica*, Rome, 1948; *Australian Journal of Scientific Research*, Australia, 1948; *Deutsche Hydrographische Zeitschrift*, Hamburg, 1948. Furthermore, the scientific reviews are constantly being extended in scope; one can even be thankful that they show a tendency to overlap. *Nature*, playing a more important part than ever before, is now supplemented by *Research*, while *Endeavour*, *Science Progress* and *Discovery* worthily maintain our reputation in the field of popular exposition. The Press is far better informed on scientific affairs than was the case a few years ago, and we can anticipate useful autocatalysis in the reaction between public appreciation and public information.

A Science Centre

A year ago I mentioned the formation of a committee to study the means whereby adequate accommodation for the scientific societies may be made available, and tactful reference to its activities will be found in the Report of Council. Without being too indiscreet, it is possible to provide some further information on a subject of great interest to the Fellows of the Society. In the first place, the Scientific Accommodation Committee has so far considered only the long-term problem, and it is matter for congratulation that representatives of so many interested parties reached full agreement on this aspect. It was unanimously agreed that the institution of a science centre would provide the best solution. Naturally, everybody would like to know where that will be and exactly what the proposal involves. In regard to the first point, a specific suggestion is being explored, and we hope that it will soon be possible to announce a definite outcome, such that a suitable site will be allocated for the eventual creation of a worthy science centre. It is unlikely that this site will please everybody; but we have reason to believe that a large majority will welcome it in view of the many advantages secured. In any event, we have the assurance that favourable consideration will be given by Ministers to transference to a better site, should such be found.

The course of the discussion showed that the co-operation of several scientific societies depended on that of the Royal Society, and your representatives

accepted the flattering implications, though not without some hesitation. To speak directly, that means willingness, if necessary in the general interest, to leave Burlington House and to function as the heart of the science centre located elsewhere.

The elaboration of so far-reaching a scheme is not at all a simple matter, and involves polypartite negotiations and agreements. The Fellows of the Society will be directly consulted on the major issue just so soon as it can be put to them in a precise form.

One possibly related matter may be adumbrated at this early stage, so that we may think about it.

The Report of Council mentions the reconstitution of a 'Rutherford Memorial Committee', which has various schemes under consideration. At the last meeting of this Committee I ventured to suggest that, as one aspect of the memorial, a 'Rutherford Hall' of noble design should form a part of the science centre, and this was given general approval by the Committee and later by Council.

Freedom of Science

Unfortunately, I must now turn from these roseate dreams of future glory to an incident of the present which has rudely disturbed our peace of mind. It is possible that our information is incomplete, or even inaccurate; but it is probable that we have ascertained the more important facts of the case.

I refer to the report that eminent Russian biologists have been constrained to subscribe to interpretations of the data in the field of genetics which they had previously rejected, or perhaps had thought unworthy of serious consideration. According to *Pravda*, "The Academy of Sciences forgot that the most important Principle in Science is the Party Principle". That is a forthright declaration which leaves little scope for ambiguity. The incident is evidently of political, rather than of scientific, importance, and the Royal Society is not concerned with politics.

We regret that the Academy of Sciences of Moscow has broken off its long correspondence with us. We trust that the new conditions will not seriously impede the advance of biological science, for which such qualifications as 'Western' are as irrelevant as they would be for a multiplication table. We impute no blame and express no opinion as a body, but that does not mean that we must take no cognizance of the occurrence, which may have some lessons for us, at least by way of analogy. For example, we may observe that governments are not infallible, yet must be obeyed. This reflexion should make us more than ever alert to preserve intact the prized freedom of science in our own domain. Actually no direct attack is likely here, and should the unexpected happen it will certainly not be along the lines of compelling us to espouse some particular scientific theory or doctrine. Conceivably it could take the more subtle form of control of the character and direction of our scientific work. There is immediate danger in the current deprecation of fundamental research, not of course absolutely, but relatively, in comparison with technological applications. I hope it will be the opinion of all Fellows that the Royal Society should take a leading part in upholding our ideals and in clarifying ideas on these topics, and particularly in insisting on the vital role which the highest kind of disinterested investigation must take in the life of the community. It is certainly not sufficiently realized that the body scientific can only flourish when all its organs are in a healthy condition. As in a biological equilibrium, there is a natural interdependence between pure and applied research. Pure science is fertilized by the advance of technology and *vice versa*. It would be quite consistent, though lamentable, to take up the position that we will have no more research at all, and devote our energies to the exploitation of present knowledge. But it is impossible to dissect the elements of real progress. If we isolate one of the limbs of the organism it will not grow, and will soon die.

Progress of Science

I do not propose to add more than brief comment on new scientific discovery. It will be conceded that the great privilege of addressing the Fellows of the Royal Society is not without its own peculiar embarrassments. For example, I have recently delivered two lectures summarizing results of many years in my own field of work. If I venture on other ground I shall be speaking as an amateur to some of the leading specialists in the world.

Without attempting any kind of assessment of values, or any completeness of survey, I will mention a few things that have been brought to my notice in recent months, often as the result of casual conversation.

Two years ago I referred to the very great value of spectroscopic methods for the study of complex molecules of organic compounds. Since that time there have been striking applications of both ultra-violet and infra-red absorption measurements which have solved some otherwise intractable problems. But one difficulty that threatened to impede progress was the management of minute quantities of material, especially in the solid state.

Dr. C. R. Burch, Warren Research Fellow, has built a reflecting microscope which is perfectly achromatic, and this has now been harnessed to an ultra-violet spectrometer by Barer, Holiday and Jope, and to an infra-red spectrometer by Thompson, Barer and Cole. In the latter case the spectral range 1–14 μ can be covered, and the results are identical with those obtained with larger specimens in more usual apparatus.

The spectra of single biological cells or single crystals weighing less than 10^{-9} gm. have been measured. Polarized infra-red radiation has also been used, and this promises to open up a new method for study of biological specimens, such as muscle fibre, in which orientation exists, as well as new possibilities for crystal analysis. This arises from the relations existing between absorption and orientation of the vibrating groups, whence the angle between certain characteristic bonds and the crystal axis can be determined. Measurements have already been made with minute quantities of new antibiotics and similar substances in connexion with their identification, or the diagnosis of their molecular groups.

The importance of this advance for organic chemists and biochemists cannot be exaggerated. It will surely lead to the routine study of the infra-red absorption of many new compounds, and the relation between the spectra and constitution will therefore become still better known. As the method thus increases in power the demand for its help must also become more insistent.

I am most grateful to Dr. H. W. Thompson for advance news of this remarkable development in

technique, details of which will be published in a short time. Soon we shall all be repeating the wistful inquiry that ends Barrie's play: "How much do they cost—those machines?"

I cannot pretend to be competent to discuss applied mathematics, astronomy, or physics; but it is obvious even to the uninitiated that great advances are being made in our knowledge of the mesons and of nuclear fission.

Sir George Thomson, in his Bakerian Lecture, gave a fascinating account of the evidence provided by study of the effects of cosmic rays on atoms, while Prof. E. O. Lawrence, with the aid of his new synchrocyclotron, has been able to produce mesons in the laboratory for the first time.

Prof. E. A. Milne's forthcoming new book will evoke lively discussion, for he tells me that acceptance of his theoretical system involves the assumption that Planck's constant h varies secularly with the time.

On the technical side we hear from America of a new type of valve, a crystal of germanium, which can be made to function as an amplifier.

Coming nearer to my personal interests, the chemists and biologists of Parke, Davis and Co. are to be warmly congratulated on their discovery and investigation of chloromycetin, a new antibiotic which has proved to be highly effective against scrub-typhus and certain analogous infections. The constitution of chloromycetin has not yet been disclosed; but it is said to be known, and apparently the substance has been synthesized. It makes possible the first satisfactory chemotherapy of a disease caused by a Rickettsia, and opens up the possibility of the control of virus diseases more generally.

Another discovery of vast medical, agricultural and biochemical interest arises from the isolation of the intrinsic anti-pernicious anæmia factor from liver. This brilliant consummation, a further triumph of modern chromatography, has been reached by A. Lester-Smith and his colleagues in the Glaxo Laboratories and by a team of chemists of Merck and Co. (New Jersey), led by K. Folkers. The red crystalline substance contains cobalt in a co-ordination complex which has a molecular weight of about 1,600 and probably includes three atoms of phosphorus. It is proposed to call the factor vitamin B_{12} and it is one of the most physiologically active of known substances, a dose of one microgram daily being fully effective therapeutically.

The picture is very quickly being filled in; we heard from Dr. Marston quite recently of his outstanding researches on the cobalt requirements of sheep. A defect of cobalt in the soil leads to sickness and stunted growth with anæmia. Other recent and related work by Drs. Tosic and Mitchell at Aberdeen concerns the assimilation of cobalt by micro-organisms. We may be sure that knowledge of the constitution of B_{12} will suggest other correlations, perhaps with nucleotides, perhaps with folic acid, which will be of vast significance. The molecule is not especially complex by modern standards and its structure can be determined, provided sufficient effort is made. If I am reminded that we are unable to synthesize penicillin, the reply would be that the problems are not comparable. Analysis of substances of this degree of complexity must nowadays always succeed, whereas synthesis may present a difficulty of a different order altogether. The trouble will be to get enough of the factor for investigation by ordinary methods, and this is a good illustration of the value of micro-physical devices. I am told that the infra-red absorption spectrum, determined by the new technique previously mentioned, has already given valuable information, confirming the presence of PO, NH and OH groups, and indicating absence of aliphatic CH, but probable presence of aromatic CH as in benzene or purines.

We seem to be on the verge of great discoveries in another field perhaps not entirely unconnected with the last-mentioned, namely, the problems connected with the effects of chemical substances on cell growth, including malignancy. There cannot be said to be any satisfactory treatment of cancer by chemical means, though various agents exert a beneficial effect in special cases. Such are stilbœstrol, testosterone and the so-called nitrogen mustards. Of these, stilbœstrol has the best claim to be regarded as a curative agent in a proportion of cases, and the halo-alkylamines ameliorate the condition of the patient. In the United States, Dr. Rhoads and his colleagues have paid much attention to antagonists of folic acid. These are synthetic compounds the molecules of which are planned to resemble those of folic acid. Several of them have been found to exert an inhibitory effect on the bone marrow, producing anæmia, which can be reversed by folic acid. Similar antagonism is observed with bacteria, and furthermore Hertz has reported that certain of these substances inhibit the action of stilbœstrol on the oviduct of the chick.

One of the most promising of the substances is called A-methopterin. This is folic acid with an amino-group replacing hydroxyl and a methyl group replacing hydrogen, quite a close analogue. The substance is anti-folic, anti-œstrogenic, and it has a definite inhibitory effect on the growth of tumours in laboratory animals, as well as of malignant cells in tissue culture. Folic acid is regarded as necessary for the growth of all cells, and the hope is to find a substance of low toxicity which will antagonize this factor to the level necessary to immobilize the more sensitive malignant growth without serious detriment to normal cells. It is known that laboratory work has encouraged clinical trials, but the results have not yet been disclosed.

Dr. T. B. Heaton and my wife have published a preliminary account of work which finds its origin in observations made many years ago on a growth-inhibiting constituent of yeast (Heaton, 1926). This was a differential growth-inhibitor affecting the connective tissue cells but not the epithelia of cultures *in vitro*.

They have now prepared carbohydrate material from wheat middlings which is either itself active, or more probably contains an active principle. This produces retrogression of the implanted Walker carcinoma in rats.

It is decidedly interesting to find such a substance in a foodstuff; it may even be a vitamin. Since in some of the earlier experiments the material had been held at a low *p*H, the formation of hydroxymethyl-furfuraldehyde was a possibility, and it was known that many aldehydes possessed growth-inhibitory properties. It was found that hydroxymethylfurfur-aldehyde, or better its polymeride, also caused the retrogression of the tumours. The connexion, if any, between these findings is not yet clear.

At the Chester Beatty Research Institute, Dr. A. Haddow and his colleagues have tested the effects on normal growth of a number of pyrimidine deriv-atives. The developments have sprung from experi-

ments designed for other purposes—and the sequence is of more than passing interest. It started with the yellow enzyme and a series of experiments designed to test the effect on growth of a series of synthetic analogues of the flavins.

Administration of 9-phenyl-5 : 6-benzo-*iso*-alloxazine to albino rats was accidentally, and most unexpectedly, found to produce an orange-yellow pigmentation of the hair (Haddow, Elson, Roe, Rudall and Timmis, 1945). Pursuing this curious observation, other coloured substances of a similar type were tested, and among them xanthopterin, the butterfly wing pigment, first isolated by Wieland and Schöpf in 1925. This did not colour the coat but produced a significant enlargement in the size of the rat kidney. It was an actual growth of the organ due to a great outburst of cell division in the kidney tubules.

In the course of still another research, that on the carcinogenicity of many styrylpyrimidines (Haddow and Kon), it was found that two substances of this group closely allied to xanthopterin in structure had the same effect in increasing the growth of the kidney. This cannot be mere coincidence and proves that the effect is a primary one of xanthopterin and the related pyrimidines on the cell. The phenomenon has been observed in the rat, mouse, *Peromyscus*, the rabbit, hamster and guinea pig.

Now xanthopterin is of natural occurrence in the kidney and it is possible that it is present as a growth regulator. Its structural relationship with folic acid will not be overlooked. Haddow and his associates feel that it is at least as important to study the means by which normal growth is so delicately adjusted as to inquire directly why the malignant cell is unregulated.

There are further experimental foundations for these ideas which lead Haddow and his collaborators to surmise that the co-ordinated growth of the normal tissues may depend upon the supply of essential substances from an external source and that, contrariwise, malignant cells may have acquired the power to synthesize these essential substances, or their equivalents, themselves. Such suggestions are fully consonant with all that we know of the subject as a whole and give a new prospect for the chemistry of growth and differentiation.

I am much obliged to Dr. Haddow for kindly acquainting me with results and ideas which are not yet published in full and for permission to mention them to-day.

I would not like to leave this subject without an incidental reference to Berenblum's significant discovery of sensitization of tissues to the action of carcinogenic agents. The constituents of croton oil, for example, directly or indirectly, prepare the ground for a carcinogenic hydrocarbon in a remarkable manner. The underlying biochemical processes may be hard to bring to light; but the effort to do so would doubtless be repaid with interest.

As a drama like that of the pyrimidine group unfolds we can look back on the steps of the pioneers and be thankful that they selected the paths which led into such rich territory. But it often appeared to contemporaries that they were wandering into a barren wilderness. Whatever makes Hopkins think that there can be any possible interest in the pigments of butterflies? Why does Windaus waste his time and talent on that impossible substance cholesterol? I have heard those actual questions asked in past years and would invite consideration of the answers that can be given to them now.

Another thought arising from recent progress is that the world of biochemistry, though of vast extent and interest, is finite, and we are beginning to sense the existence of its boundaries. We seem to encounter the same thing more often than might be expected; coincidences are indeed of frequent occurrence.

An example has already been mentioned and another is the recent discovery that the photodynamic colouring matter of St. John's wort, hypericin (Brockmann *et al.*, 1939, 1942; Pace and McKinney, 1941; Dhéré, 1939, 1943) is closely allied to a pigment of the Aphididæ, erythroaphin, studied by A. R. Todd and his collaborators at Cambridge (1948). Further, these substances are related to a mould pigment, oxypenicilliopsin, isolated by Oxford and Raistrick (1940). The pigments are *bis*-anthracene derivatives of some kind and it is surprising to find these little investigated and highly characteristic substances so widely distributed in Nature.

A notable coincidence in my own field of work arose very recently from a theory of Woodward regarding the course of the synthesis of strychnine in the plant. He advanced what seemed at first the fantastic idea that a benzene nucleus, originally that of dihydroxyphenylalanine (or tyrosine), suffers fission so as to give two oxidized chains which enter into further transformations.

Transferring this mechanism piecemeal into an entirely different group of alkaloids, it was found to predict that constitution of emetine which can now be experimentally demonstrated to be correct. I am glad of this opportunity to say that I was unaware until quite recently of parallel, independent work by Dr. H. T. Openshaw on the constitution of emetine. This was submitted for publication some months ago and includes the establishment of one detail of the structure not fully proved by the work of Späth, of Pailer and of Karrer. A few months ago no connexion whatever could be discerned between strychnine and emetine, they seemed poles apart. Now at one stroke they are connected by recognition of a common and remarkable type of biogenesis.

A PROPOSED INSTITUTE OF BIOLOGY

By Dr. J. F. DANIELLI

INSTITUTES or analogous foundations have rendered great services to physicists, medical men, engineers, chemists, anthropologists and many other professional groups. No such foundation exists to serve the needs of biologists. Recently the Biological Council, consisting of representatives of nineteen different biological societies, was asked by a number of these societies to examine the possibility of forming an Institute of Biology. In a preliminary investigation the views of a number of representative biologists were obtained, and information was also available from the Institute of Biology recently established in the United States under the auspices of the National Research Council.

There are two aspects of an Institute which are of general interest: on one hand there is the daily life

of an Institute; and on the other hand, there is the long-term influence of an Institute on policy.

The setting up of an Institute would immediately give to biologists a central address and general office service, and should ultimately provide a club and meeting rooms. An Institute would produce a bulletin to carry news and notices, maintain a watch on legislation and international matters of interest to biologists, maintain an employment bureau, and protect the standards of employment of its members, if need be by providing legal aid. A public relations service would be maintained, members would be advised in their dealings with the Press and with publishing firms. Special income-tax problems would be considered and the establishment of special relationships with trading firms and with insurance offices would be sought. Such day-to-day activities constitute a group of sound reasons for forming an Institute.

Of equal importance are the arguments based on consideration of policy. These include:

(*a*) The lack of a representative body of biologists. This causes two difficulties. It is difficult for those who are not biologists to obtain a measure of the balance of biological opinion on matters which may, for example, come within their province of administration. It is also difficult for biologists to place proposals before Government and other bodies, since at present such proposals cannot receive the backing of a representative body.

(*b*) Biology is becoming of increasing importance in industry and for the economic and physical well-being of the country. But at present the authority of biologists in these fields is restricted, and often in consequence insufficiently serious consideration is given to the purely biological aspects of a problem. The modification of this position is hampered by lack of professional organisation, by the general ignorance of biological factors and by the prevailing dominance of the strong professional organisations of chemists, physicists, veterinarians and medical men.

(*c*) Many biologists are now going into industry and their numbers are likely to increase. In the absence of any recognized Institute of Biology there is a tendency for membership of academic societies to be quoted as a qualification. This is an undesirable practice which may reach serious proportions. It did so, for example, in the cases of the Chemical Society and the Psychological Society. The formation of a recognized Institute with established qualifications for admission would put an end to this practice.

(*d*) Biologists are still badly paid in comparison with other professional groups. It is felt that this is at least in part the result of there being no professional body to look after the interests of biologists.

(*e*) The channels whereby biologists may be recruited are sometimes inadequate, and appointments too often depend mainly on chance. This situation would be improved by formation of an Institute with an appointments register. It is of interest that, in one recent year, out of the ten thousand members of the Institute of Chemistry, no fewer than one thousand made use of the appointments register.

(*f*) The formation of an Institute of Biology, embracing both academic and applied biologists, would be of national service, since it could assist in securing better financial support for biological research. It would also perform a most valuable service in surveying the position of biological science in general education, and the more specialized training of professional biologists.

With these considerations in mind, the Biological Council has decided to conduct a postal ballot of biologists, the distribution of ballot papers being made by the affiliated societies. In this ballot biologists are asked to state whether they would support an Institute, and to give the Council their opinions on the formation of an Institute.

An Institute can be formed only if a sufficiently large number of biologists are prepared to support it. If this support is forthcoming, the Biological Council will call a central meeting of biologists, at which officers and a provisional council can be elected. For the first year of its foundation the Institute could be run on a largely voluntary basis, during which time a constitution would be evolved, office premises found, etc.

The Biological Council envisages the Institute being open to all who are engaged in biology as a profession. Those joining would probably fall into two categories of membership, namely, associate members, holding an honours degree in biology or its equivalent, and full members, holding a degree of D.Sc. or its equivalent. In addition, provision should be made for scientific societies to become affiliated to the Institute. The Council of the Institute we envisage as elected in two ways—some of the members being elected by the individual members of the Institute, and others nominated as representatives of the affiliated societies. But the final decision on these details would, of course, be taken when a constitution is agreed upon.

It is not intended to exclude people who have no degrees, or to limit full membership to those with D.Sc. degrees. There is no reason why a biologist should not be either an associate or full member while having no degree, provided he has a training, or has achieved a status, which can be regarded as equivalent to that indicated by a degree. However, it may well be that the foundation members will prefer to have only one category of membership. All decisions on such matters, including the constitution, will, of course, rest with those biologists who indicate, by voting in the Biological Council's ballot, a desire to participate in the formation of an Institute of Biology.

Biologists who are members of a society affiliated to the Biological Council will receive a ballot paper from their society. Those who are not members of an affiliated society may obtain a ballot paper from one of the joint secretaries of the Biological Council, namely, Dr. J. F. Danielli, The Chester Beatty Research Institute, Royal Cancer Hospital, Fulham Road, London, S.W.3, or Dr. W. P. K. Findlay, Forest Products Research Laboratory, Princes Risborough, Bucks, or Prof. J. Z. Young, Department of Anatomy, University College, Gower Street, London, W.C.1.

The societies affiliated to the Biological Council are: Anatomical Society, Genetical Society, British Mycological Society, Linnean Society, Nutrition Society, Society for General Microbiology, Pathological Society, Biochemical Society, Pharmacological Society, Physiological Society, Society for Experimental Biology, British Ecological Society, Royal Entomological Society, Marine Biological Association, Association of Applied Biologists, Royal Horticultural Society, Eugenics Society, Association for the Study of Systematics in Relation to General Biology, and Society of Applied Bacteriology.

OBITUARIES

Prof. E. F. Burton, O.B.E.

ELI FRANKLIN BURTON, director of the Physics Laboratory, University of Toronto, died in Toronto on July 6, 1948.

Born in February 1879, he attended high school in Toronto and took the honours course in mathematics and physics at the University of Toronto, graduating in 1901. His first researches were carried on under the late Prof. J. C. McLennan and included work on the penetrating radiation from the earth (they just missed discovering the cosmic rays). Burton then proceeded to Cambridge in 1904 as an 1851 Exhibition Scholar and worked under J. J. Thomson on colloidal particles. Returning to Toronto, he assisted McLennan in the fitting up of the new physics building (now called the McLennan Laboratory) and obtained his doctorate of philosophy in 1910. He was promoted to an associate professorship in 1911 and to full professorship in 1924. In the First World War he was a member of a team consisting of McLennan, Satterly, Dawes and Patterson (of the Meteorological Service of Canada), and occupied himself with the problem of the estimation of helium gas in the natural gas of Canada and its extraction therefrom for use in balloons. He also was acting head of the department when McLennan was called to Britain to assist in the scientific work at the Admiralty.

On the return of peace and McLennan, Burton and his assistants continued his work on colloidal solutions and later published a monograph on the physical properties of colloidal solutions. A third edition of this book was published with the collaboration of Miss May Annetts in 1936. At one time he was very interested in the application of colloidal arsenic solutions to abate the onset of cancer, and in this work he was assisted by Dr. Hendricks. Although he fought hard for recognition of his method and he had concluded from X-ray photographs that the method had some advantages, the medical profession remained cold and the work was eventually dropped.

Just after the beginning of the Second World War, Burton had the intuition that radio-location would play a vital part in the contest. He tried hard to interest the Services and to get them to send their brighter men to take a course in radar; but they declined. Then he enlisted the support of a Toronto Kiwanis Club, who provided sufficient monetary assistance to enable the Physics Department of the University of Toronto to run a summer course in 1940 for about twenty selected men. Burton had the satisfaction in later years of knowing that some of these men, in ship and on land, filled very important posts in the Empire radar services. In the succeeding years he almost forced the Services to start classes in radar not only in Toronto but also across the Dominion, for the Royal Canadian Air Force and the Canadian Army, and eventually a large number of men were trained who served in all parts of the world.

Burton was also a director of Research Enterprises, Ltd., a Crown research company managed by Colonel Eric Phillips, now chairman of the board of governors of the University of Toronto. 'R.E.L.', as it was called, built huge factories and laboratories at Leaside just outside Toronto in which all kinds of apparatus for war purposes were made and assembled; mention need only be made of radar outfits, optical glass, periscopes and range-finders. Because the men could work under better and quieter conditions than in Toronto, the very complicated radar sets for the large battleships of the Navy were built at Leaside. As side issues, Burton promoted (with Pitt) the invention and design of proximity fuses for shells, and other investigations on the flight of shells, and directed research on problems in audition connected with shell shock. For this work he was awarded an O.B.E. in 1943. It was a great grief to Burton when, after the end of the War, the Government decided to relinquish all the work at 'R.E.L.' and to sell parts of the establishment; he had hoped that a portion of it would be maintained as a factory for the manufacture of scientific apparatus for use in Canada.

On McLennan's retirement from Toronto in 1932, Burton became director of the Physical Laboratory, and soon after that developed with A. Pitt and others the study of valve circuits, leading in one instance to the Burton–Pitt electrical method for the determination of the water content of grains and soils. The low-temperature work (initiated by McLennan) on helium and the superconductivity of metals was carried on by Burton and others. The study of the viscosity of liquid helium I and II, with the discovery of the very low viscosity of liquid helium II, opened up a new field which he, with the help of Wilhelm and Misener, vigorously prosecuted. Also, with the help of Grayson-Smith and others, he carried on the work of superconductivity and in 1934 published a small book on the subject.

Elected to the fellowship of the Royal Society of Canada in 1913, he became president of the Mathematics, Physics and Chemistry Section in 1934–35 and was awarded the J. M. Tory Medal in 1947. He was also president in 1931–32 of the Royal Canadian Institute, a Toronto society which gives public lectures on scientific subjects adapted for the general public. As a member of the National Research Council of Canada for many years, he gave much of his time and energy to the furtherance of scientific work in Canada and for providing means for young Canadians to stay at home and develop their own country rather than emigrate to the United States.

During the war years, Burton encouraged Prebus and Hillier to build an electron microscope. This was based on an existing European design and was probably the first electron microscope set up on the American side of the Atlantic. Burton gave Hillier and his successors all the backing he could, so that the Toronto School of Electron Microscopy has been in the forefront of this work, and many of the men who have been through it have secured important posts in the United States.

The physics building of the University of Toronto was sorely overtaxed for space during the war years, and as soon as labour was available Burton persuaded the board of governors to build a new wing to the building, which increased the total space by about thirty per cent. The new wing was named by the governors the "Burton Wing", and Burton was enabled to see it unofficially opened in May 1948. In this new wing there are special suites for research work on low-temperature problems, radio-work, and especially for electron microscopy. The Electron Microscope Society of America met here in September to honour the man who had done so much, but unfortunately he had passed away before he could receive their congratulations.

Dr. Burton was one of the most cheerful and kindly of men. Unfortunately, in later years his energy was

undermined by diabetes and heart-shocks, and in his last year failing memory and eyesight robbed him of his lively good humour. He leaves an honoured name in Toronto and Canada generally. He is survived by his widow and one son and one daughter.

JOHN SATTERLY

Dr. Susan Isaacs, C.B.E.

SUSAN ISAACS died on October 12 at the age of sixty-three. Few can have had a greater influence in our time on the upbringing and education of children; indeed, the modern trend towards full recognition of the human aspect of nursery school and subsequent education owes much to her work.

Dr. Isaacs was the daughter of William Fairhurst, of Bolton, Lancashire, and of Miriam Sutherland. Educated at Bolton Secondary School and at the Universities of Manchester and Cambridge, she became a research student at Cambridge in the Psychological Laboratory in 1912, and then lecturer in psychology at Darlington Training College. In 1924 she was invited to become principal of the Malting House School at Cambridge. It was during the following three years that she gathered the comprehensive data of children's behaviour, thoughts and feelings which she presented brilliantly in her two books "Intellectual Growth in Young Children" (1930) and "Social Development in Young Children" (1933).

In 1933 she was made head of the new Department of Child Development of the University of London, at the Institute of Education. She held this post with outstanding success for ten years. In the course of that time a large number of experienced teachers and educationists were enriched by the wide and deep new knowledge which she was able to impart, and above all by her vivid sense of every child as a full, living personality, needing to be imaginatively realized and understood in his own right.

Dr. Isaacs turned to the new insight offered by Freudian psycho-analysis as soon as this work became generally known in England, and joined the British Psycho-Analytical Society in 1921. She was appointed a psychologist on the staff of the London Clinic of Psycho-Analysis in the year 1931. She remained on the staff of the Clinic until her death, and contributed signally in a great number of ways to the scientific work of the Society and to the practical work of the Institute. She was a valued member of the Training Committee and of the Council.

Dr. Isaacs was a clear writer as well as teacher and lecturer; her books and scientific papers are well known to students of psychology to-day. Her small handbook for mothers and teachers, "The Nursery Years", written in 1929, is known all over the world; it was awarded the Parents' Magazine Medal in the United States. "The Children We Teach" is another little book which is widely popular. One of the two books published just before her death is "Childhood and After", containing essays and clinical psychological studies which belong to the later period of her life [see review on p. 871]. A chapter in it called "Children in Institutions", originally a memorandum presented to the Home Office Care of Children Committee, known as the Curtis Committee, 1945, was probably the most important single document consulted by that Committee.

Dr. Isaacs' gifts were based on a combination of intellectual and emotional factors. Her passionate interest in the conditions, first, of young children's education, and, secondly, of their general upbringing in the home, arose out of her own experiences. Her mother's death when she was just six, terminating a fatal and incapacitating illness which started when Susan was barely four, led her to find in her first elementary school in a Lancashire town in the 1880's a refuge and solace from the tragedy at home, but also to become very quickly a rebel against its manifold constraints and inadequacies. This disappointed eagerness and keen sense of what 'school' might have been like, but in fact was not, remained in the background of her mind throughout her growth and did much to shape her later life-work.

It became clear to her at an early stage in her development that mere criticism and mere abandonment of existing methods could bring no constructive results. She quickly assimilated and adopted the most advanced educational ideas current at the time, and her immediate response to the new teaching of psycho-analysis showed that no conventional opposition or resistances could stand in the way of her unhesitating acceptance of anything that offered her wider horizons and deeper understanding. In the same way, at a later stage, when Melanie Klein's ideas were first put forward in Great Britain, she was among the earliest to sense the further sources of knowledge which were now opening up. She saw how these new ideas could be developed to the general benefit of every child's upbringing, and from that moment she pursued that knowledge, and applied it untiringly up to the very last.

Her outstanding intellectual characteristic was an extremely rapid and comprehensive grasp of the matter in view and an ability to classify and summarize it, to present it with remarkable clarity, and to discuss it from various angles. Her exceptional capacity for instantly translating her thoughts and impressions into verbal expression served as a powerful instrument for all her other gifts.

It was characteristic of Susan Isaacs that when she found that there was a great deal which she had not yet encompassed, especially in the work of Melanie Klein, she decided (although she was already a member of the British Psycho-Analytical Society) to start again as a trainee and to go through the whole course. Thus she developed further, undergoing a second long personal analysis, and greatly enriched her own work and the contribution which she was eventually able to make to general psycho-analytic research. In her last years she devoted herself almost entirely to actual analytic practice, and felt this to be the most satisfying of the various kinds of work she had done.

In her husband, Nathan Isaacs, she had a constant friend and supporter, and a constructive critic.

DR. FRANTIŠEK BĚHOUNEK, lecturer in radiology at the Charles University of Prague, died at the end of October at the age of fifty. He had been a pupil of Mme. Curie and had developed a method for measuring atmospheric radioactivity. In 1926 he accompanied General Nobile on his ill-fated polar expedition, and when the airship *Citta di Milano* came to grief they were rescued by the Russian ice-breaker *Krassin*. Běhounek, with Heyrovský, wrote the standard Czech text-book of radioactivity.

NEWS and VIEWS

Science in the U.S.S.R.

In his presidential address to the Royal Society, delivered on November 30 (see p. 872), Sir Robert Robinson refers to the restrictions which have been placed on biological teaching and research in the U.S.S.R. Also simultaneously, his predecessor in the presidential chair of the Royal Society, Sir Henry Dale, has resigned his honorary membership of the Academy of Sciences of the U.S.S.R., because, as he says in a letter to the president of that Academy, "I believe that I should do a dis-service even to my scientific colleagues in the U.S.S.R. if I were to retain an association in which I might appear to condone the actions by which your Academy, under whatever compulsion, is now responsible for such a terrible injury to the freedom and the integrity of Science". In his announcement of his resignation, Sir Henry recalls that his election took place while he was president of the Royal Society, and that it was widely welcomed among British scientific men "as the symbol of a community of purpose between the scientists of our two nations . . . in defending, as we believed, the freedom of Science, as of all man's proper activities, from the threat of an aggressive tyranny". He points out that in the same year, 1942, N. I. Vavilov was elected a foreign member of the Royal Society in recognition of his contribution, by research in the U.S.S.R., to advances in genetics. But Vavilov had fallen into disfavour, and even now the Royal Society does not know whether he was alive at the time of his election to foreign membership. "More recent events, of which full reports have come to hand, have made it clear what has happened. The late N. I. Vavilov had been replaced by T. D. Lysenko, the advocate of a doctrine of evolution which, in effect, denies all the progress made by research in that field since Lamarck's speculations appeared early in the nineteenth century. Though Darwin's work is still formally acknowledged in the U.S.S.R., his essential discovery is now to be rejected there. The whole great fabric of exact knowledge, still growing at the hands of those who have followed Mendel, Bateson and Morgan, is to be repudiated and denounced; and the last few, who were still contributing to it in the U.S.S.R., have now been deprived of position and opportunity. This is not the result of an honest and open conflict of scientific opinions; Lysenko's own claim and statements make it clear that his dogma has been established and enforced by the Central Committee of the Communist Party, as conforming to the political philosophy of Marx and Lenin. . . . It remains to be seen whether such compliance with dogma is to be exacted in other departments of Science. So far as we know only that of the genetics encouraged by Lenin is now prohibited as alien to his political philosophy."

Dr. H. J. Muller, the distinguished American geneticist, has also resigned his honorary membership of the Academy of Sciences of the U.S.S.R.

Royal Society: Officers for 1949

At the anniversary meeting of the Royal Society on November 30, the following were elected as officers and council for the ensuing year: *President*, Sir Robert Robinson; *Treasurer*, Sir Thomas Merton; *Secretaries*, Sir Edward Salisbury and Prof. D. Brunt; *Foreign Secretary*, Prof. E. D. Adrian; *Other Members of Council*, Prof. J. D. Bernal, Prof. G. R. Cameron, Sir James Chadwick, Prof. S. Chapman, Prof. H. Davenport, Sir Frank Engledow, Prof. W. E. Garner, Prof. A. C. Hardy, Dr. C. H. Kellaway, Prof. G. F. Marrian, Sir William Stanier, Dr. H. G. Thornton, Prof. C. E. Tilley, Dr. A. E. Trueman, Prof. S. Zuckerman.

British Association: Newcastle Meeting, 1949

Next year the British Association for the Advancement of Science will meet in Newcastle-upon-Tyne (August 31–September 7). The Council has completed appointments to the various offices in the Association; these include: *President*, Sir John Russell; *General Treasurer*, M. G. Bennett; *General Secretaries*, Dr. Edward Hindle and Sir Richard Southwell; *Presidents of Sections*, Sir Harold Spencer Jones (Physics and Mathematics); Sir Alfred Egerton (Chemistry); Prof. W. J. Pugh (Geology); Prof. A. C. Hardy (Zoology); Prof. L. Dudley Stamp (Geography); Sir Alexander Gray (Economics); Sir Arthur Fleming (Engineering); Mr. M. C. Burkitt (Anthropology and Archæology); Prof. R. A. Peters (Physiology); Prof. Godfrey H. Thomson (Psychology); Prof. Lily Newton (Botany); Sir Fred Clarke (Education); Prof. N. M. Comber (Agriculture). The chairman of the Local Executive Committee is Lord Eustace Percy. The Lord Mayor of Newcastle has issued an appeal for a local fund of £4,000, and more than two hundred local volunteers are already making preparations for what is expected to be one of the largest meetings in the history of the British Association.

Unesco: New Director General

At the Third General Conference of Unesco now being held in Beirut, M. Jaime Torres Bodet, Mexican Foreign Minister, has been elected director general in succession to Dr. Julian Huxley, who has held office since the inception of Unesco two years ago. M. Bodet, who is forty-six years of age, was head of the library department of the Mexican Ministry of Education during 1922–24. From 1924 until 1928, he was professor of French literature in the University of Mexico. In 1929 he entered the Foreign Service and successively held positions in Mexican legations in Spain, Holland and France. During 1936–37 he was director of the Diplomatic Department of the Ministry of Foreign Affairs and the following two years he spent as chargé d'affaires in Brussels. From 1940 until 1943 he was Under-Secretary for Foreign Affairs, after which he was appointed Minister of Education. In this capacity he conducted a campaign against illiteracy, founded circulating libraries, organised a system of rural education, and devoted his whole time to the orientation and administration of education in Mexico.

Bicentenary of Berthollet

Claude Louis Berthollet, the associate of Lavoisier and himself a distinguished chemist, was not a native of France but was born at Talloires, near Annecy, in Savoy, on December 9, 1748. He was educated at Chambéry and at Turin. After taking his doctor's degree at the latter place he became physician to Philip, Duke of Orleans, in which capacity he made a name for himself as a chemical discoverer. In 1781 he was made a member of the Academy of Sciences of Paris and afterwards became director of the Government dye works. His discovery of the

composition of ammonia was made in 1785 and that of the bleaching power of chlorine in 1786. With Lavoisier, Fourcroy and Guyton de Morveau he compiled the "Methode de Nomenclature Chimique" in 1787. He was one of the first to become a convert to the views of Lavoisier. The Revolution, while it brought him into danger, also called forth his organising powers, and it was largely due to his efforts that the saltpetre supply of France was maintained at a critical time. With Monge and Clouet he did much to improve and extend the manufacture of steel. In the reorganisation of the Academy and the inauguration of the Institute in 1795 Berthollet took an active part. Napoleon appointed him and Monge as heads of a Commission to select from the spoils of Italy the choicest works of art, and Berthollet was one of the group of French men of science who accompanied him to Egypt. In 1803 he published his well-known "Essai de statique chimique". Four years later he founded the famous Société d'Arcueil, comprising as members Laplace, Biot, Gay Lussac, Thenard and one or two others. After the suicide in distressing circumstances of Berthollet's son, the Society was broken up and from that time Berthollet lived in retirement. He was a senator, a grand officer of the Legion of Honour, and under the empire was created a count. He died at Arcueil after a long and painful illness on November 6, 1822. His character was amiable, frank and sincere. Though he enjoyed a great reputation in his time, he was modest and unostentatious and his honesty and courage were sufficient to impress even Robespierre. His eulogy was pronounced before the Academy of Sciences by Cuvier.

Radioactive 'Tracers' for Germany

A CONTRACT for the supply of radioactive tracers to approved research institutes in the Bizone of Germany has recently been placed with the Atomic Energy Research Establishment, Harwell, by the Joint Export–Import Agency, following the decision of the Isotope Allocation Committee of the Ministry of Supply in January last that radioactive 'tracers' produced in the Harwell Gleep could be made available for research work in Germany. The decision of the Isotope Allocation Committee was communicated to the authority responsible for the control of research in the British Zone, who immediately informed the U.S. Research Control Group. Together they approached the board of the import agency, supported by their respective public health advisers: and with the minimum of delay the Board authorized the import of radioactive tracers from Harwell into the Bizone.

Research institutes in the Bizone thus gain access to a range of radioactive tracers, the indigenous production of which is denied to Germany under Control Council Law No. 25 for the Control of Research. Their allocation within the Bizone is the responsibility of a small German committee, competent to decide where proper use will be made of the small total supply of 'tracers' at present available from Harwell to Germany. In order to assist the Committee in its task, a team of experts from Harwell visited Germany during October and demonstrated the latest ancillary equipment. Thus everything possible has been done to ensure that the maximum use shall be made of the limited quantities of radioactive 'tracers' which can be spared by the Atomic Energy Research Establishment at Harwell for export to the Bizone.

Research Council of Alberta

THE twenty-eighth annual report of the Research Council of Alberta (King's Printer: Edmonton) summarizes the work of the Council for 1947. All investigations in progress in 1946 were continued and a new project involving a survey of road surface conditions existing at selected places on the main highways of the Province, both where there was evidence of deterioration of the pavement and where the road appeared to be standing up satisfactorily in service, was commenced. The Council has continued to take a close interest in the bituminous sand separation plant being erected at Bitumount on the Athabaska River, and further laboratory work has shown that the loss of oil in the hot separation process is not due to filming on to particle surfaces but to the flecks below a critical size being enmeshed among the particles and afterwards, on redispersion of the tailings, settling with the clay, increase of clay content in the bituminous sand decreasing the oil recovery. Work on the applicability of water-flooding to the bituminous sands has continued, as well as on the systematic examination of Alberta coals and on the carbonization of low-grade sub-bituminous coals in the pilot plant low-temperature retort designed on the principle of a vertical shaft carbonizer. Investigations on the preparation of Alberta coals for the market and on some aspects of the chemical constitution of coal have been commenced. The Gasoline and Oil Testing Laboratory has widened its scope and now includes the examination of aviation, jet, Diesel and other fuel oils, petrol, lubricating oils, hydraulic fluids and solvents. Geological work included investigations of coal, clays, sand, water and miscellaneous mineral investigations, the major project being a survey along Evans-Thomas, Ribbon and Pigeon Creeks to determine coal measures in that area. Under the natural gas project for the conversion of carbon monoxide and hydrogen, from natural gas and oxygen, into a product resembling crude oil, the influence of operating conditions, catalyst structure and composition on the yields of liquid hydrocarbons was further studied, and a modified Emmett apparatus used to measure the surface areas of various catalysts. A market survey of poplar products was conducted, and the soil survey programme was continued in co-operation with the Dominion Department of Agriculture and the University Department of Soils. Tests were also made on the utilization of quartz sand and of straw.

Field Archæology in Great Britain

A NEW report, the "Survey and Policy of Field Research in the Archæology of Great Britain. 1: The Prehistoric and early Historic Ages to the Seventh Century A.D.", has recently been published by the Council for British Archæology, Institute of Archæology in the University of London (1948; price 5*s*.). The object of this publication is to consider briefly—in only 120 pages—the present state and future desirable direction of British field research. A number of archæologists have epitomized, without references, their present ideas about the periods under review and have pointed out where further work should be undertaken to settle doubtful questions and to fill in gaps. The idea of giving a present starting point and of suggesting where investigators should concentrate their efforts in the future is excellent. But it is not easy of execution. A volume issued under the auspices of the Council for British Archæology might be considered as indeed author-

itative, yet the reader should remember that some of the statements made are really matters of opinion of the writers concerned and not universally agreed upon. For example, a number of investigators cannot agree with the statement at the top of page 21, and will affirm on the contrary that the industries in the top gravels of the 100-ft. terrace below London are indeed quite late and do belong to the same series as those from East Anglia mentioned at the bottom of page 20. Again, in such a short epitome is it not perhaps a pity to have introduced a totally new nomenclature for the glaciations which has not yet been to any extent accepted? The considerable cave excavations of Upper Palæolithic industries are dismissed in about three sentences, which is scarcely sufficient. The Neolithic Age is allowed three pages. Those who have studied the period will know the subject-matter already, while those who are less instructed will find the discussion far too condensed. But such a work lends itself to criticisms on almost every page, and yet undoubtedly it has a definite value. It covers a far wider range in time than most archæological works dealing with Great Britain, and in spite of criticisms of details, it does give a bird's-eye view of what is known of the period under review. The pin-pointing of what is required to be discovered by future investigators is also very useful.

Agricultural and Horticultural Research Station, Long Ashton

THE annual report of the Agricultural and Horticultural Research Station, Long Ashton, for 1947 has now been published (price 10*s*.). The problems of the cider industry naturally play a prominent part in the work of the Station, and a list of suitable varieties for planting has been drawn up. Sweet and bitter-sweet sorts are specially advised, since many orchards at present contain too high a proportion of sharp varieties. Studies on the chemical composition of different ciders have been started and already fresh lines for further research work are indicated, which may well lead to results of practical importance. Another group of papers deals with the black currant crop. New varieties are described, and management and manurial treatment discussed. The nitrogen requirement of this crop is particularly high, and composts and stable manure alone have proved inadequate. Both fruit and vegetable crops are included in the investigations on plant nutrition. New methods have been developed for studying molybdenum deficiency in sand culture, while in the soil acidity investigations, some account is given of how the specific effects of aluminium toxicity, manganese toxicity, and calcium deficiency in various crops may be distinguished. As regards plant pests, a fluorine compound, *bis*-(β-fluoroethoxymethane), has been found to exert remarkable insecticidal properties, when watered on the soil, on beans and cauliflowers. Although compounds of this type cannot be used in commercial horticulture in view of their extremely poisonous nature, the discovery is of importance, for by it, light may be thrown on the process of translocation within the plant tissues.

Local Government

THE problem of the definition of local government areas for one purpose or another is a very complex one. The needs of local administration have long outgrown the existing framework, and for every aspect of local government the boundaries need to be redrawn. In a paper in the *Geographical Journal* (111, 4–6) entitled "The Boundaries of Local Government Areas", Mr. E. W. Gilbert discusses some of the problems involved, especially as the geographer sees them, with reference to the "Local Government Boundary Commission Report" for the year 1946. A valuable feature of his paper is the series of twenty maps of England and Wales showing boundaries of areas that have been used or suggested for the different purposes, including gas and coal boards, electricity, railways, hospitals, post office, weather forecasts, and so forth. The divergence of views is obvious from these maps. Provinces or areas, each with a regional consciousness, do occur; there is no question of that; but the difficulty lies in their definitions. Even as regards towns the problem is not easy since town boundaries are arbitrary and do not coincide with the urban areas. Again, it is essential that the confines of an administrative region should embrace an area of which all parts are easily accessible in terms of time and expense. This feature has much to do with the growth of regional consciousness.

"Silva of North America"

"SILVA OF NORTH AMERICA", the authoritative description of the trees which grow naturally in North America exclusive of Mexico, by Prof. C. S. Sargent, long out of print, has now been reprinted by Peter Smith, 321 Fifth Avenue, New York, 16, in a limited edition, complete with all the illustrations, in fourteen volumes (bound in seven) at 200 dollars net. Permission to reprint these books was granted to Peter Smith by Dr. E. D. Merrill, director of the Arnold Arboretum.

Announcements

SIR EDWARD APPLETON, secretary of the Department of Scientific and Industrial Research, has been appointed principal and vice-chancellor of the University of Edinburgh. It has also been announced that Sir Edward has been awarded the Valdemar Poulsen Gold Medal of the Danish Academy of Technical Sciences, "for outstanding contributions to radio technics and particularly for remarkable achievement in research on the ionosphere". The award was instituted in commemoration of the work of Dr. V. Poulsen, the inventor of the Poulsen arc and a pioneer of radio-telephony, who received the first medal on the occasion of his seventieth birthday on November 23, 1939.

MR. ROGER DUNCALFE has been elected chairman of the General Council of the British Standards Institution in succession to the late Sir Clifford Paterson.

THE Council of Scientific and Industrial Research, India, has established an Indian Scientific Liaison Office in London, and Dr. S. Bhagavantam, who was professor of physics in the Andhra University, Waltair (India), has been appointed chief scientific liaison officer. This Office is with the Scientific Liaison Offices of the other Dominions, at Africa House, Kingsway, London, W.C.2.

THE price of Richardson's "Veterinary Protozoology" reviewed in *Nature* of November 13, p. 756, is given as 10*s*. net. We are informed by the publishers, Messrs. Oliver and Boyd, Ltd., that the correct price is 18*s*. net.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A New Heterochromatic Fabry–Perot Fringe System Applicable to the Interferometry of Absorption Spectra

PARTIALLY successful attempts to apply the high resolving power of Fabry–Perot étalons to the study of astronomical absorption spectra have been made by Burns[1], Shane[2] and others. None of the arrangements hitherto employed has been successful in securing complete independence of the resolution from the slit-pattern distortion of the spectrograph, an effect which is always present in the high-dispersion spectrographs which these methods require for the primary dispersion.

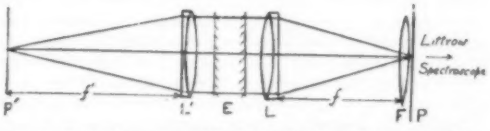

Fig. 1. Optical arrangement for the production of heterochromatic Fabry – Perot fringes

I have experimented with a new optical arrangement, which is depicted in Fig. 1. The Oxford solar spectrograph, a Littrow prismatic instrument with a dispersion of 1½ A./mm. and resolving power not exceeding 10^6 at 5890 A., produced a spectrum of the solar centre in the plane *P*. Behind this plane was placed a second collimating lens *L* and a second camera lens *L'*. This system formed a second spectrum in the plane *P'*. The field lens *F* was introduced in the plane of the first spectrum *P* to obviate vignetting effects. When a small étalon was introduced into the parallel beam between *L* and *L'*, the second spectrum was broken up into a system of concentric circular interference fringes.

These figures resemble, superficially, normal Fabry–Perot fringes, but differ from them in three essential respects.

(1) The new fringe system is heterochromatic, being constructed of fringes of equal chromatic order. The large wave-length range over which the fringe system extends will be seen from the accompanying photograph (Fig. 2) of the *D* region.

(2) The centre of the pattern does not coincide with the axis of the étalon, but is displaced by an angle $f(d\lambda/dx)/\lambda$, where λ is the wave-length, f the focal-length of the second collimator, and $d\lambda/dx$ the dispersion at *P*. In view of the high dispersion of the Oxford instrument, and the short focal length (25 cm.) of the second collimator, this angle amounted to a few degrees only, a fortunate fact, to which the recognition of the fringe system was largely due. When the spectral region is altered by changing the setting of the minimum deviation link-work of the main spectrograph, the centre of the pattern becomes alternately bright and dark, and gradually shifts in relation to the étalon axis, in consequence of the varying prismatic dispersion.

(3) The intensity distribution within the fringes is a Fabry–Perot analysis of the instrumental slit pattern. Consequently a necessary condition for the production of the fringes is that the primary monochromatization produced by the main spectrograph shall correspond to a wave-length range smaller than the range of the étalon.

As a consequence of the third property of the fringes, the effect of widening the slit is to produce a pattern of much broadened fringes with an approximately square-topped intensity distribution. Within the fringes of this broadened system the solar absorption lines appear, broken up into short sections of Fabry–Perot ring systems of the normal monochromatic type, concentric with the axis of the étalon. The resolution of these absorption lines is completely independent of the instrumental slit pattern, and is entirely determined by the resolution of the étalon and plate-grain effects. The possibility of obtaining full resolving power with a wide slit, in contrast to Shane's method, allows a reduction of exposure time of the order of 100. Thus for the first time it becomes possible to make use of the high resolving power of really heavily silvered étalons.

The accompanying photograph of the *D* region was taken with a slit-width of 0·2 mm., étalon spacer 2·5 mm., reflectivity greater than 0·9. The exposure time was 13 min. Some idea of the actual improvement in resolving power will be given by comparing the interference photograph with the normal spectrum, taken with slit-width 0·025 mm. It will be seen that the line 5884, which is at the very limit of resolution in the normal spectrum, is very clearly split into two components in the interference photograph. This line appears single in Minnaert's photometric atlas, and is quoted in the Revised Rowland Catalogue as an iron line with a water-vapour companion too close for accurate measurement. The resolving power so far attained is provisionally estimated as about 400,000, and it is believed that the present limit is set by plate grain, owing to the somewhat short focal-length camera (50 cm.) thus far employed.

It is obvious that the method will be of wide applicability to problems of solar wave-length measurement, and to the photometry of absorption line contours. Plates for wave-length determination

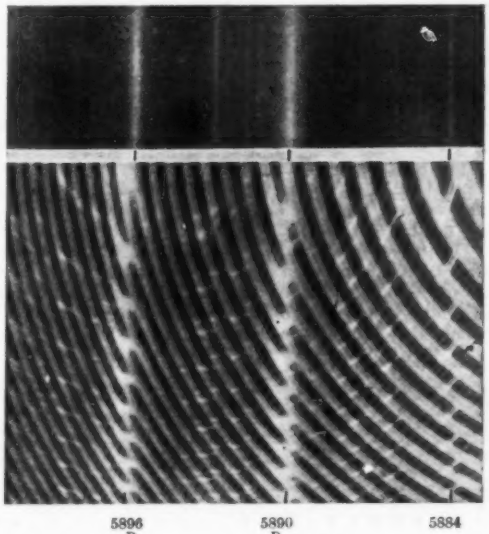

Fig. 2. Direct and interference photographs of the *D*-region of the solar spectrum (negative prints)

in the D region and for contour measurements of broad and narrow solar absorption lines in the region of the line Ca 4227 are now in process of measurement. A full account of the new fringe systems, and of these applications, will shortly be communicated to the Royal Astronomical Society.

P. J. TREANOR, S.J.

University Observatory,
Oxford.
Oct. 1.

[1] Burns, K., and Meggers, W. F., *Pub. Allegheny Obs.*, **6**, 105 (1927).
[2] Shane, C. D., *Lick Obs. Bull.*, **19**, 119 (1941).

Short-Period Changes in the *F* Region of the Ionosphere

RADIO observations designed to detect horizontal movements in the ionospheric regions and to investigate the relation of these to previously observed changes occurring above a single observing point have been in progress for some months in the vicinity of Sydney, New South Wales. The present system uses three transmitters (T_1, T_2, T_3) placed at the apexes of a right-angled triangle with its shorter sides approximately north–south and east–west and of length 13 miles and 27 miles respectively (Fig. 1). The

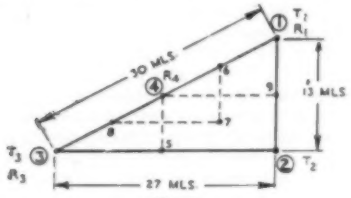

Fig. 1

transmitters are operated on the same frequency and with the same repetition frequency, and are so phased, by either mains synchronization or pulse triggering technique, that the three pulses are spaced about 50 km. apart on a normal type of time base such as is used for ionospheric observations. It is thus possible to record the three sets of echoes simultaneously on a single film. Standard 35-mm. film is used, moved continuously with a film speed of ¾ inch per minute. Observations can be taken at one or more of three points, two being at the most widely spaced transmitting sites (R_1 and R_3), and a third at a point approximately midway between these (R_4).

Assuming that a reflexion point is vertically above a point on the ground midway between transmitter and receiver, we have eight possible points for checking uniformity of motion.

During seven months of operation (November 1947–May 1948), it has been observed very frequently that several types of clearly defined changes which occur in echoes from the *F* region show a time difference of occurrence at the spaced points.

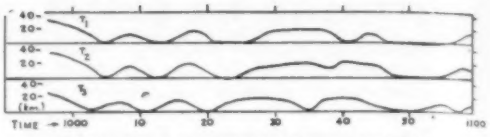

Fig. 3. Comparison of 'splits' observed at point R_3

Fig. 2 shows a particularly clear example of one type recorded at R_3. In this case the traces are produced by applying the signal to the intensifier electrode only of the cathode ray tube. The uniform lines are height marks spaced 100 km. apart. The top trace is the *F* region echo from transmitter T_3. The time base and height marker are initiated by this transmitter, so that the changes in virtual height are real.

The transmitters T_2 and T_1 are synchronized with T_3 through the 50-cycle power supply grid. Their traces (at R_3), therefore, show different amounts of phase fluctuation relative to T_3 and to the height marker, and their apparent changes in height may not be real. Corrections can be made if a ground ray is also visible on the screen; but this requires a closer scale with some loss of resolution. The transmitters T_1 and T_2 are interrupted for a few seconds at intervals of one minute (except every tenth minute on R_1), to provide time marks on the records.

It will be observed that there is a sudden disturbance on each trace in the form of a temporary splitting of the echo lasting about one minute (not easily seen in the reproduction). It occurs first on T_3, three minutes later on T_2 and a further minute later on T_1. An almost identical pattern was recorded four minutes later at R_1, which eliminates any possibility of the time differences being due to slight differences in frequency or to the small differences in the angles of incidence. The deduced direction of horizontal motion in this case is 60° east of north, and the velocity in this direction 3·9 miles per min.

Another common type of variation is shown in Fig. 3, which is a condensed plot of the amount of 'split' (difference in virtual heights of ordinary and extraordinary rays) for the three echoes as observed at R_3 over a period of one hour on the following day. It will be observed that quasi-periodic variations appear in almost the same form on all three traces, but with time differences which are of the same order as in Fig. 2.

Fig. 4 is a plot for the following hour of the virtual heights of the two components as observed at vertical incidence at R_3 and R_1. Here it will be seen that the two magneto-ionic components at each point (as shown by the full line and the dotted line) go through a very similar sequence of changes, but there is a time lag between the dotted and full-line curves. It will be noticed, however, that the time of travel from R_3 to R_1 is the same for both components. The time difference in this case is about seven minutes, as we are observing the full distance R_3 to R_1 and not the half-distance as in Figs. 2 and 3.

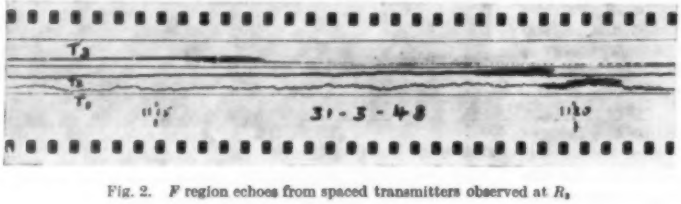

Fig. 2. *F* region echoes from spaced transmitters observed at R_3

We thus appear to have definite evidence of some form of horizontal progression in the *F* region. The great majority of cases analysed so far have given horizontal directions between 30° and 60° east of north, and deduced velocities between 3 and 5 miles

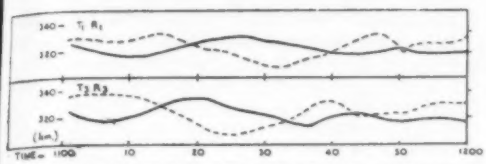

Fig. 4. Changes in virtual heights at points 1 and 3 (30 miles apart)

per minute. The observations have been made between 9 a.m. and 5 p.m. local time on a frequency of 5·8 Mc./s.

Changes in virtual height of the type shown in Figs. 3 and 4 appear most likely to be produced by changes in the ionization gradient. The effects observed might be due to either a horizontal drift in the atmosphere, with superimposed local variations in ionization gradient, or to progression of a wave motion of such a nature as to cause changes in ion concentration (for example, a pressure wave). Present evidence seems to favour the second alternative.

The time difference in the occurrence of the changes in the two rays in Fig. 4 suggests that there may be also a vertical component in the progression. This is supported by some $h'f$ observations which have been made at R_4 during occurrences similar to those of Fig. 4. They show a progression of such changes along the $h'f$ curve for the F region from the higher to the lower frequencies, corresponding to a progression from a greater to a lesser height.

Further observations are in progress to extend and clarify the information already obtained. The results will be reported more fully elsewhere.

This work has been carried out as part of the programme of the Radio Research Board of the Commonwealth Council for Scientific and Industrial Research, and is published with the consent of the Council. I wish to acknowledge the invaluable help of the staff of the Sydney Section of the Radio Research Board in carrying out the observations and to express appreciation of the keen interest of Sir John Madsen, chairman of the Board, which has made this work possible.

G. H. Munro

Electrical Engineering Department,
University of Sydney. June 22.

Evidence of Horizontal Motion in Region F_2 Ionization

During the winter periods of 1942 and 1943, a series of relative field-strength measurements were made at the Radio Research Station, Slough, on signals from the German short-wave sender Zeesen situated 990 km. east of Slough[1]. Subject to the assumption that local time variations corresponded with longitude variations in the ionosphere, it was observed that the time of the initial appearance of the oblique ray signal at sunrise agreed closely with the value to be expected from calculations based on normal incidence ionospheric observations at Slough[2]. These sharp sunrise variations in the ionosphere occurred at Slough some thirty minutes later than at the mid-point of the oblique trajectory; this corresponds closely to the local time difference between Slough and this mid-point. It was noted, however, that in addition to these regular sunrise ionospheric changes of large magnitude, there were small irregularities in the F_2 layer occurring near the mid-point of the oblique trajectory, which were repeated overhead at Slough some 60–75 minutes later.

It is interesting to speculate on the reason for the repetition of small changes in region F_2 at two sites 500 km. apart along a line of latitude with a delay of one hour or more. It seems possible that the explanation lies in a rapid east–west motion of or within region F_2 ionization. An examination of many records indicates an average value of about 70 minutes for the delay time, requiring a velocity of 430 km./hr. in a direction east to west at the level of the F_2 layer at the time of such observations.

W. J. G. Beynon

Department of Physics,
University College of Swansea.
Oct. 20.

[1] Beynon, W. J. G., *Proc. Phys. Soc.*, **59**, 521 (1947).
[2] Appleton, E. V., and Beynon, W. J. G., *Proc. Phys. Soc.*, **52**, 518 (1940); **59**, 58 (1947).

Latitude Effect of Penetrating Cosmic Ray Showers

It has been shown by Broadbent and Jánossy[1] that penetrating cosmic ray showers are of two types: (*a*) local penetrating showers; (*b*) extensive penetrating showers. Local penetrating showers are supposed to be produced by primary nucleons, and they give rise to a transition effect which is proportional to mass. Extensive penetrating showers appear to be parts of extensive air showers. They show a strong transition effect in lead but almost none in paraffin.

From theoretical considerations, Jánossy[2] has suggested that local penetrating showers are produced mainly by nucleons that are latitude-sensitive. It is therefore expected that the transition effect of local penetrating showers might show a marked latitude effect.

In order to test this prediction, we have set up a penetrating-shower recorder situated at geomagnetic latitude 4° S. at sea-level in Colombo. This recorder is illustrated in Fig. 1 and is identical with that used by Broadbent and Jánossy[1] in Manchester. It consists of three trays of eight counters each, arranged as shown. Each tray covers an area of 1,000 cm.^{2}. The trays are separated by 15 cm. of lead absorbers, and in addition the middle and the bottom trays are shielded at the sides and ends by about 50 cm. of lead. The top tray is divided into three independent groups of counters, while the middle and the bottom trays are each divided into two groups as shown. Sevenfold coincidences (designated P) consisting of the simultaneous discharge of at least one counter of each group were recorded. These coincidences are due to the occurrence of showers of at least two particles capable of penetrating 30 cm. of lead absorber.

In order to select the local penetrating showers, a fourth tray of unshielded counters (not shown in the

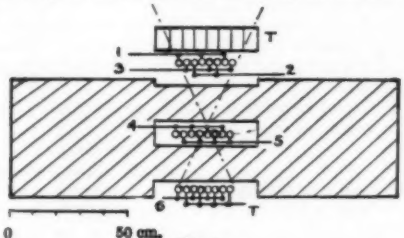

Fig. 1

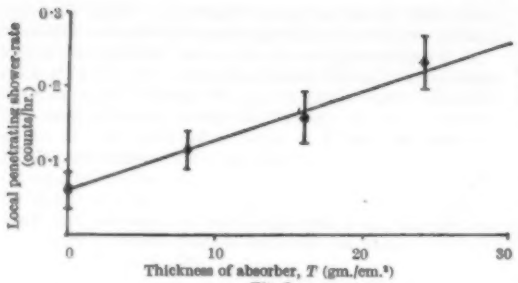

Fig. 2

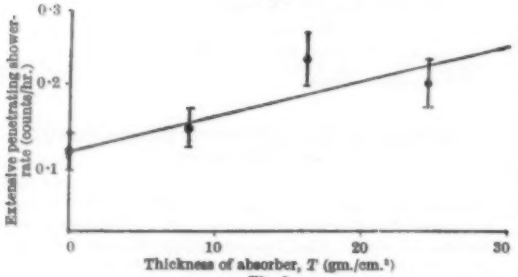

Fig. 3

figure) forming a single group of effective area 2,500 cm.² was placed near the top tray. Eight-fold coincidences between P and at least one of the counters of the fourth tray were also recorded. These coincidences are due to extensive penetrating showers. Anticoincidences, that is, P coincidences not accompanied by the discharge of any of the counters of the fourth tray, are then due to the local penetrating showers.

We have in the first instance measured the transition effect in paraffin. Various thicknesses of absorber 48 cm. × 48 cm. were placed close above the top tray in the position T (Fig. 1). Our results are given in Fig. 2, the deviations shown being standard deviations. From a comparison of the results for Manchester and Colombo, we obtain the following values for the transition effect of local penetrating showers :

	Shower-rate for $T=0$ (coincid./hr.)	Initial slope of transition curve	Estimated max. shower-rate (coincid./hr.)
Manchester	$0{\cdot}051 \pm 0{\cdot}008$	$5{\cdot}7 \times 10^{-2}$	0·30
Colombo	$0{\cdot}060 \pm 0{\cdot}019$	$6{\cdot}7 \times 10^{-2}$	0·35

It is seen that the transition effect in Colombo is of the same order as that in Manchester. Hence there appears to be no observable latitude effect of penetrating showers. We have also measured the transition effect of extensive showers and found an indication of an effect in paraffin. The actual increase observed is from $0{\cdot}107 \pm 0{\cdot}026$ coincidences/hour without paraffin to $0{\cdot}208 \pm 0{\cdot}035$ coincidences/hour under 24·3 gm./cm.² of paraffin. The effect is shown in Fig. 3.

It is hoped to publish elsewhere a detailed account of our work on completion.

V. Appapillai
A. W. Mailvaganam

University of Ceylon,
Colombo.

[1] Broadbent and Jánossy, *Proc. Roy. Soc.*, A, **190**, 497 (1947).
[2] Jánossy, *Proc. Roy. Soc.*, A, **183**, 190 (1944).

Origin of Cosmic Rays

It is important to decide whether or not the main sources of the cosmic ray particles are external to our galaxy. An external source seems, at first sight, to be established by the observed isotropy of the cosmic rays incident on the earth. But it has been claimed by a number of authors that this isotropy is simply a consequence of a magnetic field assumed to exist in interstellar space. The basis for this claim is that a *single* particle of energy η and charge e is deflected through an appreciable angle after travelling a distance d across a magnetic field of intensity H, provided

$$H \sim \eta/ed.$$

For η equal to 10^{18} eV., e equal to the electronic charge ($4{\cdot}77 \times 10^{-10}$ E.S.U.), and d equal to the radius of the galaxy ($\sim 3 \times 10^{22}$ cm.), the necessary value of H is about 10^{-18} gauss. This value may be compared with the average interstellar field of about 10^{-20} gauss that would result if (i) every star possessed a magnetic moment equal to the commonly quoted magnetic moment for the sun ($\sim 1{\cdot}5 \times 10^{34}$ C.G.S.); (ii) the stellar magnetic dipoles were all aligned parallel to each other.

Although, even with these favourable assumptions, the interstellar magnetic field is still too small to be of consequence in this connexion (by a factor $\sim 10^{2}$), it has nevertheless been argued (*a*) that the magnetic moment of the sun may be exceptionally small, (*b*) that the connexion between angular momentum and magnetic moment suggested by Blackett[1] leads to an interstellar magnetic field $\sim 10^{-19}$ gauss. In view of these possibilities it is desirable to consider the matter afresh.

We find that the effects of a magnetic field as high as 10^{-19} gauss are still negligible. A fallacy underlies the usual type of argument, because the question cannot be decided through investigating the behaviour of an isolated particle. It has been shown that the motions of the cosmic ray particles are not appreciably disturbed by the field, provided

$$H^2 \ll 4\pi W,$$

where W is the energy density of the rays. Using the observed value $W \sim 10^{-12}$ ergs per cm.³, this gives $H \ll 10^{-6}$ gauss, which is satisfied by a large margin even if Blackett's views are accepted.

The physical basis of the above inequality is easily understood. When this inequality is satisfied then, whatever the electromagnetic processes taking place within the particle distribution, the momentum density of a uniform beam of particles of energy density W is large compared with the average momentum density of the electromagnetic field. Our conclusion follows from the conservation of momentum, as applied to an assembly of particles moving in an electromagnetic field.

We see, therefore, that the main source of the cosmic rays must be external to the galaxy. An important consequence is that the source must be adequate to give an energy density $\sim 10^{-12}$ ergs per cm.³ not only in interstellar space but also in *internebular* space. One of us[2] has discussed elsewhere the implications of this conclusion.

J. W. Dungey
Magdalene College, Cambridge.

F. Hoyle
St. John's College, Cambridge.

[1] Blackett, P. M. S., *Nature*, **159**, 658 (1947).
[2] Hoyle, F., *Mon. Not. Roy. Ast. Soc.*, **106**, 384 (1946).

Effect of Hydrogen Atoms on Intensities of X-Ray Reflexions

In calculating the intensities of X-ray reflexions (diffractions) from crystals, it is customary to disregard contributions that may be due to hydrogen atoms. Their single electrons will tend to merge with the distributions about other atoms to which they are chemically bound, and the relatively small disturbance of the symmetry about these other atoms can usually be safely neglected.

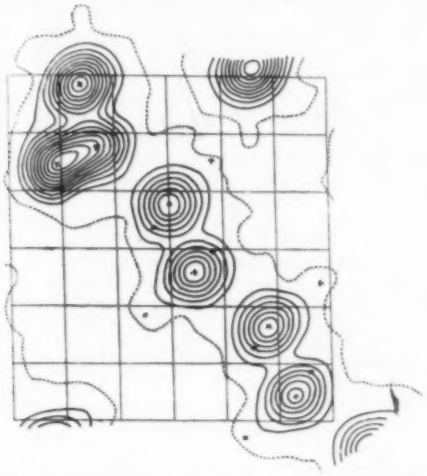

Fig. 1. Portion of sebacic acid structure. Contour scale, one electron per line

However, in discussing the results of some quantitative X-ray studies of aromatic hydrocarbons, especially coronene, $C_{24}H_{12}$, attention has been directed to certain small bulges on the electron density maps which appear close to every carbon atom to which a hydrogen atom should be attached[1,2]. Although these features are clearly visible, the total effect is too small to have much influence on the intensity calculations. If we regard the scattering power of the various atoms in a molecule as simply proportional to their atomic numbers, then the hydrogen atoms in the coronene molecule will represent only 7·7 per cent of the total scattering power. In pyrene, $C_{16}H_{10}$, the figure will be 9·4 per cent and in anthracene, $C_{14}H_{10}$, 10·6 per cent.

For aliphatic molecules, the total effect of the hydrogen atoms will be much greater. Thus, in methane the hydrogen electrons represent 40 per cent of the total, and in very long *n*-hydrocarbon molecules, C_nH_{2n+2}, about 25 per cent. We have recently been engaged on the detailed analysis of several aliphatic structures, and we find that it is necessary to take account of the hydrogen atoms in order to obtain reasonable agreement in the intensity calculations, particularly for the low-angle reflexions.

In sebacic acid, $C_{10}H_{18}O_4$, the hydrogen electrons account for 16·4 per cent of the total, and in hexamethylene diamine, $C_6H_{16}N_2$, 24·2 per cent. A detailed analysis of the crystalline structure of each of these compounds has now been completed, and the atomic positions have been determined accurately by the Fourier series method. The effect of neglecting the hydrogen contribution in calculating the structure factors for some of the low-angle reflexions is shown by the following figures:

Sebacic acid, $C_{10}H_{18}O_4$

hkl	$\sin\theta/\lambda = 1·54$	*F* meas.	*F* calc. C, O and H	*F* calc. C, O only
001	0·071	33·5	34·5	47·5
002	0·141	11·0	12·5	17·0
$20\bar{1}$	0·171	11·5	11·5	4·0
$20\bar{2}$	0·154	3·0	4·0	0
$20\bar{3}$	0·168	13·5	14·0	15·5
$20\bar{4}$	0·206	23·5	24·5	28·5
$40\bar{6}$	0·335	59·0	54·5	48·0
$11\bar{1}$	0·189	8·5	8·0	5·0

Hexamethylene diamine, $C_6H_{16}N_2$

hkl	$\sin\theta/\lambda = 1·54$	*F* meas.	*F* calc. C, N and H	*F* calc. C, N only
008	0·316	31·8	31·3	24·0
0010	0·395	14·5	13·2	10·0
0012	0·474	12·5	10·2	7·8
108	0·334	32·9	32·2	17·8
020	0·267	29·1	29·0	26·6
025	0·335	22·5	25·1	16·5
026	0·360	12·8	11·3	6·6
046	0·588	6·1	6·9	3·3

In each case the hydrogen atom is assumed to lie at 1·09 A. from the carbon atom in the direction required by a tetrahedral distribution of the valency bonds. The atomic *f*-curve for hydrogen has been given the same general shape as the empirical *f*-curve for carbon[3], but with a more rapid fall-off at large angles. It is similar to Hartree's curve[4] but with a large temperature correction.

The electron density maps for these two molecules show the presence of the hydrogen atoms very clearly.

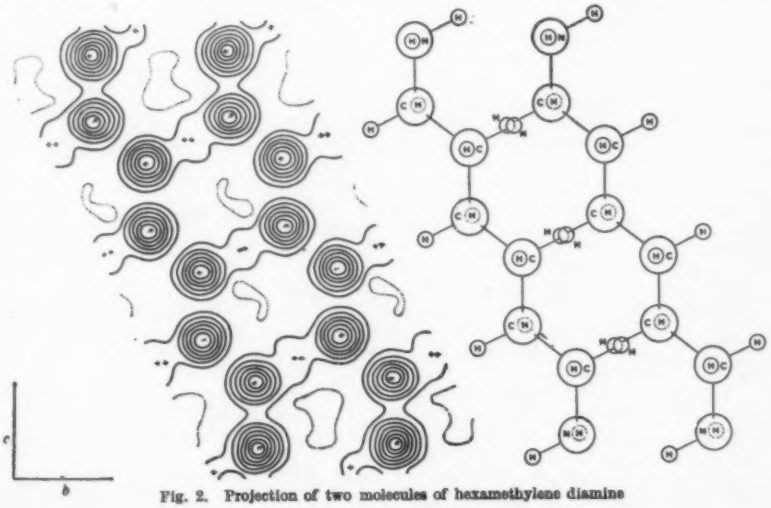

Fig. 2. Projection of two molecules of hexamethylene diamine

Four of the CH_2 groups in the sebacic acid chain are reproduced in a two-dimensional projection (Fig. 1), and the calculated positions of the hydrogen atoms are marked with small crosses.

In the hexamethylene diamine structure the crystalline arrangement of the molecules is particularly favourable for showing the hydrogen atoms in projection.

The molecules shown in Fig. 2 lie at different depths in the unit cell, but in projection the effect is to cause the hydrogen atoms of neighbouring molecules to overlap, with a consequent doubling of the projected electron density.

We are indebted to Messrs. Imperial Chemical Industries, Ltd., for materials and grants in aid of this work.

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A Proposed New Form of Dielectric-loaded Wave-Guide for Linear Electron Accelerators

It has frequently been suggested that a linear accelerator could be constructed using a wave-guide consisting of a circular metal tube lined with an insulating tube of dielectric, and several writers have recently published theoretical investigations of this type of wave-guide, as, for example, Frankel[1]. The performance of a linear accelerator using such a wave-guide is ultimately limited by the power losses which occur in the metal tube and in the dielectric itself, and calculations show that the performance compares unfavourably with other forms of accelerator, such as corrugated wave-guides[2]. However, some recent theoretical investigations show that the performance should be greatly improved by using a different form of dielectric loading, and that certain practical advantages should also ensue.

It has been shown that the losses in the metal tube can be decreased by using an anisotropic dielectric with a smaller dielectric constant in the direction of the wave-guide axis than in the transverse directions. These properties may be simulated by using a stack of isotropic dielectric laminæ in planes perpendicular to the wave-guide axis, with suitable small spaces separating the laminæ from each other. Since it is necessary to have a central hole for the passage of electrons, each lamina will be shaped like an engineer's washer, and the whole will resemble a corrugated wave-guide in which the corrugations are made of dielectric. The thickness of the laminæ and their spacing should be small compared with the wave-length in the guide in order to simulate a homogeneous material. Laminating the dielectric reduces the power losses in the dielectric itself, in addition to reducing the losses in the metal through its simulated anisotropic properties, and the total losses are found to compare favourably with those in a corrugated wave-guide.

The following table gives a few computed examples for this type of anisotropic loading:

ε	Q	ε_ρ	a (metres)	b (metres)	L_0 (metres)	η (ohm/metre)
—	—	—	0·025	0·096	11	27×10^6
100	2,000	30	0·02	0·085	100	64×10^6
95	2,000	80	0·02	0·050	17	19×10^6
16	5,000	12	0·02	0·063	100	22×10^6
16	5,000	12	0·01	0·058	100	29×10^6

where ε is dielectric constant of solid (unlaminated) loading material; ε_ρ is effective dielectric constant in the radial direction; a is radius of central hole; b is internal radius of metal tube; L_0 is length of wave-guide with an attenuation of 1·25 nepers; η, the 'efficiency' or figure of merit, is $(0{\cdot}407)\,E^2/\alpha W$; E is accelerating field; α is attenuation constant; W is energy flux in the wave-guide; $Q = \omega\varepsilon/\sigma$ for the solid dielectric. All the examples are for a wave-length of 0·25 metres. The first row relates to a corrugated wave-guide with five corrugations per wave-length and twice theoretical copper losses. The remainder are for dielectric loading, in which the Q factor shown has been taken as about half that claimed for certain ceramic materials.

The dielectric system seems to have certain practical advantages compared with a corrugated wave-guide. The dielectric washers can be made from ground ceramic material, which is relatively inexpensive, and if the spacing between washers is adjustable there should be no need to maintain the very accurate dimensions which are required in the case of corrugated guide. The outside diameter of the dielectric guide is also smaller, which should again reduce the cost of an accelerator. Finally, the design of the dielectric guide is more flexible in that widely different characteristics can be chosen. There is, of course, a number of practical difficulties which may arise; but it is not anticipated that any of these will be very serious.

It is proposed to start some experimental work at the Telecommunications Research Establishment upon dielectric loaded guides to study their practical properties.

This work was carried out as part of the programme of the Electronics Group of the Atomic Energy Research Establishment at the Telecommunications Research Establishment, Malvern, and acknowledgment is made to Sir John Cockcroft for permission to publish the results.

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[1] Frankel, S., *J. App. Phys.*, **18**, 650 (1947).
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Surface Effects with Single Crystal Wires of Cadmium

The letter of A. H. Cottrell and D. F. Gibbons, published in *Nature* of September 25, describes certain experiments which go to show that the phenomenon named 'thermal hardening' by Orowan[1,2], and recently investigated by C. L. Smith[3], is due to contamination by gaseous reaction. Experiments which we have been carrying out for some time on single crystal wires of cadmium have led us to the same conclusion. The surface of our *HS* cadmium wires, 1 mm. in diameter, was cleaned with great care, and single crystals were made by the method of Andrade and Roscoe[4], the wires being held in

loosely fitting 'Pyrex' tubes which had been baked out at 400° C. and evacuated to a pressure of about 10^{-4} mm. mercury. Thus every precaution was taken against initial surface contamination.

Three pieces were cut from a single wire, of which one was kept as control, one for further heating *in vacuo* and one for heating in air. With no preliminary strain and heating for half an hour at 200° C. both in air and *vacuo*, no appreciable effect was obtained; while with heating for about 20 hours at 200° C. in air pronounced 'thermal hardening' appeared. If, however, one end of the wire, to the extent of a few millimetres, was momentarily immersed in a solution of cadmium nitrate and afterwards dried, so that strictly local contamination was produced, a heating for half an hour in air at 200° C. produced the hardening phenomenon. This leads us to the conclusion that the formation of the surface film, which would appear to be, in any event, the first stage in the process that leads to hardening, is very much facilitated by local contamination. We cannot say at this stage whether the local contamination be oxide, nitrate or other salt. The fact that the phenomenon is so dependent upon a slight *local* surface impurity of this kind no doubt explains the irregular results that have been obtained. We reserve further observations on the nature of the phenomenon for subsequent publication.

We take this opportunity of describing very briefly certain other experiments which we have been carrying out on the effect of surface conditions on mechanical properties of single crystals of cadmium. We have found, following extensive experiments on surface conditions, that, if a single crystal with a clean surface is loaded so that it flows very slowly (at a rate of about 1 per cent per hour), the surrounding of the wire with commercial cadmium plating solution (which contains potassium cyanide, cadmium potassium cyanide, sodium carbonate and sodium hydroxide) leads to an immediate increase of rate of flow, which may be anything up to twenty-fold. The fact that the effect is immediate seems to indicate that diffusion from the surface is not concerned. With a solution of cadmium sulphate an increase of rate of from two- to four-fold is obtained, both with unstrained crystal wires and with pre-strain of up to 30 per cent. Cadmium chloride solution produces a similar effect. With a solution of cadmium nitrate, however, an immediate increase is followed by a complete cessation of flow, the wire being brought to a state of such hardening that nearly double the initial stress is needed to start flow again. Preliminary experiments with zinc nitrate indicate immediate hardening. Similar results have been obtained with single crystal wires of commercial cadmium (impurity quoted by the suppliers as about 1 in 10^5, as against better than 5 in 10^6 for *HS* cadmium) surrounded by plating solution, whereas with polycrystalline wires of commercial cadmium no effect was obtained. At present we attribute the increase of rate to the action of the cadmium ions and the hardening to the formation of a surface film, probably of oxide. The work is continuing.

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Strength of Metals

It has been shown previously that progressive deformation of an annealed metal breaks down the grains into smaller units, or crystallites, which have a minimum size characteristic of the metal[1,2]. The lower limiting size for metals so far examined lies in the range 10^{-4} to 10^{-5} cm. A precise determination of this size has become of importance, because it appears to coincide with the maximum strength developed during deformation of the metal[2].

Measurements can be made by the X-ray diffraction method, which utilizes the relation between broadening of the X-ray lines and the size of the reflecting units. Hitherto this method has been complicated by the extra broadening which occurs if the reflecting elements are in a different state of internal strain[4]. We have used the method but reduced the difficulty by two devices. First, we have confined the X-ray measurements to one direction in the metal at one time, thereby taking advantage of a recent observation that, in a systematically deformed metal, elements of the same orientation are in a similar state of strain. Secondly, we have been able to obtain X-ray back-reflexion photographs from the heavily deformed metals with much shorter wave-lengths than previously have been considered practicable, and, in this way, to distinguish the broadening due to small crystallite size, which is proportional to the wave-length, from that due to internal strains, which is independent of the wave-length.

The measurements have been made in the first instance on the body-centred cubic metals, iron, tantalum, molybdenum and tungsten, which respond particularly well to the above procedure. Thus, after deformation, these metals give very broad X-ray lines when photographed with a wave-length of the usual order, 1·5–2 A., but very much sharper lines when photographed with a wave-length of 0·5–0·7 A. The effect of small crystallite size can be shown, therefore, to be the predominant factor, and the size itself then calculated from the broadening without ambiguity.

Next, the values thus obtained have been related to the maximum tensile strength of the metals, on the general hypothesis that a metastable condition is reached when the overall elastic strain of the crystallite is equal to one interatomic spacing. The fractional strain is then of the order of d/L, where d is the atomic spacing and L the linear crystallite size; and the corresponding stress is this quantity multiplied by the appropriate elastic modulus. The maximum stress will arise when L has the minimum value given by the measured lower limiting size.

A detailed treatment, based on comparison of the energy of a crystallite before and after deformation by slip, has been given by Sir Lawrence Bragg, who obtains for the critical stress, kGd/L, where G is the shear modulus and k a constant of the order of unity[5]. This he identifies with the initial yield stress.

Much depends on the interpretation placed on the yield strength. A full discussion together with the experimental derivation of the minimum crystallite size will be given elsewhere. It is desired here, however, to record the values of the crystallite size and point out a close agreement between the quantity Gd/L and the maximum tensile strengths of the metals under consideration.

The values are given in the accompanying table. The figure taken for G for the metals iron, molybdenum and tungsten is the shear modulus in the

	L (cm.)	d (cm.)	G (tons/sq. in.)	S (calc.)	S (obs.)
Fe	$3{\cdot}0\times10^{-4}$	$2{\cdot}48\times10^{-8}$	$3{\cdot}9\times10^{5}$	32 tons/sq. in.	30 tons/sq. in.
Ta	2·4	2·85	4	47	58
Mo	4·2	2·72	8·6	56	75
W	2·9	2·74	10	95	110

slip direction [111]. This figure is not available for tantalum, and for this metal the modulus measured on the bulk metal has been used. The value of d is the atomic spacing in the slip direction. The value L for the crystallite size is the minimum reached after progressive deformation, and thus refers to the fully strain-hardened condition. Exploratory measurements of L made some years ago by W. A. Wood were purposely confined to cold-worked metals in a partially recovered condition, and therefore gave somewhat larger values. The present values for L are the ones required for comparison with the maximum strength. The table includes observed values of true tensile strengths (S obs.). The value for the iron was determined directly; the remainder were taken from published data. Unfortunately, the figures usually published are nominal strengths calculated on the initial cross-section of the test specimen, or, for the rarer metals, strengths measured on hard-drawn wires, which often are in a state of high internal strain. The values given in the table, however, suffice to indicate that the calculated strengths S (calc.) $= Gd/L$ are definitely of the right order.

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Production of Extremely Thin Metal Films by Evaporation on to Liquid Surfaces

In two articles in *Nature* of March 15, 1947, a method is given for making very thin metal films, 10–20 A. or more in material thickness. On the surface of a film of cellulose nitrate, etc., there is evaporated a small amount of, for example, beryllium or aluminium. Then the basic film is dissolved away by amyl-acetate or other appropriate solvent, the metal being left free. Such films of beryllium or aluminium are especially useful as supporting membranes for electron microscopical studies. As a rule these metal films have no visible structure. It may, however, happen that a faint structure appears even if the film is very transparent in the electron microscope. This structure effect may depend upon the fact that all the cellulose molecules are not nitrated to the same degree, some of them being insoluble in amyl acetate. Other explanations may be that a molecular layer of the cellulose nitrate adheres very closely to the metal surface and does not go into solution, or that some of the very active metal atoms have penetrated into the cellulose molecules. I have now found that the structure effect mentioned above does not exist when using acrylates instead of cellulose nitrate, collodion, etc., as the basic film. The solvent then used is ethyl acetate. The metal films made are almost invisible in the electron microscope when made 20 A. in thickness, and the photographic contrast effect of the object particles is increased compared with that obtained with ordinary supporting membranes, which is of the greatest importance when studying molecules or other minute particles.

I have recently devised another method for making thin metal films, which is simpler, since no dissolving process is needed for the basic film: *the metal film is made by evaporation in a vacuum of a small amount of beryllium or aluminium on to a liquid surface*. From the physical point of view it may seem impossible to get any metal layer in this way. It works nicely, however, and very thin films of beryllium and of aluminium can be made. I have been using several liquids, but chiefly glycerol. The liquid used must have a high boiling point and low vapour pressure at room temperature; for example, glycerol, boiling point 290° C. and vapour pressure less than 10^{-4} mm. mercury.

The procedure for making metal films on a glycerol surface is as follows. A piece of glass, about 3 cm. × 3 cm., is covered with a thin layer of glycerol (½ mm. or less in thickness) and put into the vacuum chamber. The glycerol ought not to have more than the smallest possible content of water, otherwise it will boil in vacuum. After a little while, when water which may have been absorbed in the glycerol has disappeared, a small amount of metal (beryllium or aluminium) is evaporated. The glass slope is next put into a container into which distilled water is introduced. The glycerol is dissolved and the film will immediately float off; it lies on the water surface, holding together well. The film is washed by using a container, where the water can be changed without disturbing the film. The film is transferred to a plane grid of copper, platinum or other convenient metal, the holes measuring about 0·1 mm. in diameter, and is allowed to dry. In this way it is easy to get pieces 3 cm. × 3 cm. or more, and whenever a specimen film is needed, a little piece can be cut off this ready-made film.

It is possible to make membranes of beryllium, aluminium, etc., with a material thickness of only 10–20 A., lying on grids where 80 per cent of the area is covered with only the thin metal film. Such thin films are of great interest also from the physical point of view, especially in investigations on the scattering effect of electrons penetrating thin metal films, and the contrast effect in the electron optical picture. One of the greatest advantages of this new method compared with the old method of making metal films for electron microscopical use is the possibility of laying a metal film directly on an organic substance without using amyl acetate or other liquids which affect organic substances.

I have also evaporated metals on to oil surfaces (vacuum oil); but in this case I did not obtain metal films; but there seemed to be rather big metal crystals after dissolving away the oil. According to the atomic structure of the liquids used, it may be expected that the active metal atoms are more likely to penetrate into the oil surface layer than into an ordinary liquid.

In another experiment I have evaporated aluminium metal in a vacuum on to a mercury surface. It is well known to chemists that mercury and aluminium react readily, when put into contact, growing salt-like trees at reaction points. The very unexpected thing is that this did not take place when I evaporated aluminium on to a mercury surface in vacuum. It may depend upon the fact that the

evaporated aluminium atoms cannot penetrate into mercury—possibly the surface tension will not let them penetrate, on account of crystalline structure of the liquid in the surface or in the mass itself.

When beryllium is being used, great care must be taken, due to the fact that beryllium dust has been found to be very poisonous.

The investigations described above were carried out at the Nobel Institute for Physics in Stockholm.

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'Knock' in Internal Combustion Engines

THERE is evidence that the phenomenon of 'knock' in spark-ignition engines is connected with the production of peroxides in the last part of the fuel–air mixture to be burnt. Thus we have found that of all the intermediate products of combustion which have been identified in the gases sampled from the engine, the peroxides are the only ones which possess an appreciable pro-'knock' effect. Egerton *et al.*[1] have shown that peroxides, probably alkyl hydroperoxides, are present in the pre-combustion processes, and Stern and Polliak[2] have identified hydrogen peroxide in samples taken from an engine cylinder. This work has now been extended to enable quantitative determinations to be made of the total peroxide content of gas samples. At the same time, we have determined the aldehyde content.

An electromagnetically operated valve has been developed which permits samples to be abstracted from an engine cylinder over a narrow crank period. This is used on a Ricardo E6 variable compression engine and positioned so that gas is sampled from the 'knocking' zone. At an engine speed of 1,500 r.p.m. and a valve opening period of 3° crank, a flow-rate of 200 c.c./min. of expanded gas is obtained when sampling at about the time of maximum cylinder pressure.

Secondly, we have developed a method for the determination of the total organic + hydrogen peroxide content of the sampled gases. The major difficulty is the presence of nitrogen dioxide and olefins, which obviously complicate any such determination. Our method, which is basically that of iodine liberation from potassium iodide, is as follows. The nitrogen dioxide is removed by passing the sampled gas through a trap containing an aqueous solution of sulphamic acid. This retains the peroxides in solution and at the same time destroys the nitrous acid formed from the nitrogen dioxide which otherwise would reduce the peroxides. The olefins are removed by bromine under conditions designed to minimize the loss of peroxide by interaction with bromine. Ferrous sulphate is used as a catalyst in the reaction with potassium iodide.

Thirdly, we have used essentially the bisulphite method of Lea[3] to determine the total aldehyde content.

Peroxide curves obtained using technical *iso*-octane as fuel are shown in Fig. 1. At the lower compression ratios, the engine was free from 'knock', while at a compression ratio of 9·9, 'knock' of a fairly heavy intensity occurred. On all these curves a rise in pre-flame peroxide concentration takes place prior to 'top dead centre', followed by a much higher peak value just before the flame. With increase of compression ratio there is an earlier rise in peroxide concentration and a much higher peak value. Surveying the large number of these curves which we have obtained there appear to be indications of a slight discontinuity just after 'top dead centre', suggesting that the curves are two-stage in nature.

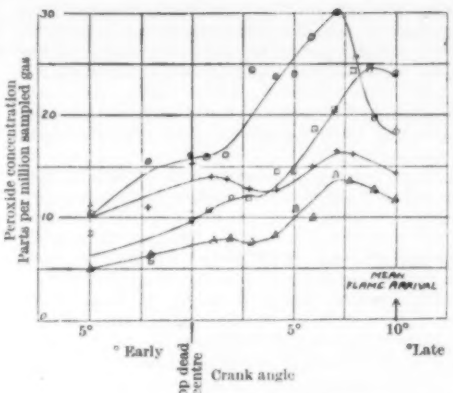

Fig. 1. Pre-flame peroxide concentration

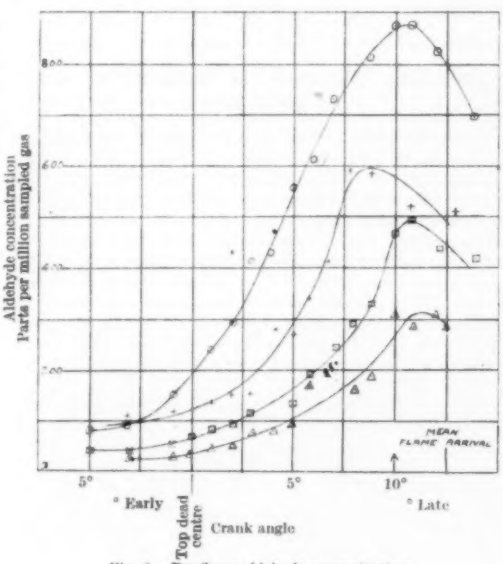

Fig. 2. Pre-flame aldehyde concentration

	Compression ratio	Fuel
△ — △ —	7·0	Octanes
□ — □ —	8·0	Octanes
○ — ○ —	9·9	Octanes 'knocking'
+ — + —	9·9	Octanes + 3 c.c. T.E.L./I.G.

The effect of the addition of tetraethyl lead to suppress 'knock' is to lower the concentration of peroxides, as compared with the curve on the unleaded fuel at the same compression ratio. The effect appears to be greater after 'top dead centre' than before, thus tending to confirm the two-stage nature of the curves.

The aldehyde curves (Fig. 2) show a smooth rise up to the time of flame arrival, achieving a peak concentration some thirty times greater than the

peak peroxide value. The effect of increasing compression ratio on the aldehyde concentration parallels the effect on the peroxide curve. Tetraethyl lead uniformly decreases the aldehyde concentration at all points.

As regards the nature of the aldehydes produced, repeated tests with dimedone gave only the formaldehyde derivative.

This work has been carried out at the Ricardo Laboratory on behalf of the Shell Petroleum Co.

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Infectious Chlorosis of Bananas in the Cameroons

During recent years, there has been a considerable extension of the cultivation of the Gros Michel banana in the British Cameroons. Vascular wilt disease (*Fusarium oxysporum cubense*) and *Cercospora* leaf-spot disease (*Cercospora musæ* Zimm), which are both present there, are already well known to the planting community. Here I wish to direct attention to a virus disease which I observed during a recent visit. This disease, which has been described as 'infectious chlorosis' or 'heart rot' by Magee[1] and Morwood[2], has been recorded in New South Wales by these observers[3] and in Guadeloupe and Haiti by myself[4,5].

In the Cameroons, infectious chlorosis has been observed in several plantations. The virus is known to be transmitted by the aphis *Pentalonia nigronervosa*[1]; this is also present. According to the Australian workers, this disease is potentially as destructive as the better-known bunchy-top disease, caused by a different virus but also transmitted by the banana aphis. In the Cameroons the evidence (so far as I was able to ascertain during a brief visit) is that infectious chlorosis is at present of occasional occurrence but is capable of spreading under the local environmental conditions. Accordingly, Magee's warning of the possible destructiveness of this disease should be given due heed by all concerned with this valuable industry.

The symptoms include a characteristic chlorosis of the leaf (linear spots from midrib to margin), the development of localized, internal regions of necrosis in the leaf sheaths of the trunk, rotting of the heart leaves and the death of the plant before the onset of fruiting[3].

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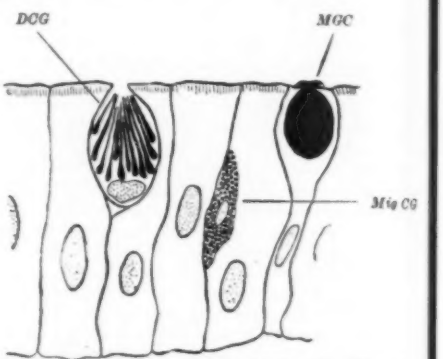
Coarse Granulocytes in Epithelial Tissues of Teleost Fishes

In the course of an investigation of blood-cell formation in teleost fishes, a peculiar formation has been seen in the intestinal mucosa and gill epithelium. Apparently the coarse granulocytes commonly found in these tissues migrate towards the surface and the granules elongate, appearing like long narrow clubs with pointed ends converging towards the epithelial surface. This regular characteristic pattern of arrangement was first noted by Duthie[1] in the mesenteries of teleost fishes of the families Labridæ and Triglidæ. I have seen it in the intestinal mucosa and gill epithelium of *Ctenolabrus rupestris* (Labridæ) and *Trigla cuculus* (Triglidæ), and also in the same sites in trout and roach. In trout and roach I have observed similar formations in the walls of kidney tubules and in the peritoneal coat of many internal organs.



Intestinal mucosa of trout. Fixed Zenker-formol. Stained Giemsa.
DCG = Discharging coarse granulocyte; *MGC* = mucous goblet cell; *Mig CG* = migrating coarse granulocyte

Careful examination of dogfish, frog and mammalian material has not revealed a single example of such a condition. The appearance suggests a discharge of a fluid substance from the interior of the granules. These modified granules may be regarded as vesicles, containing a fluid which is discharged at the epithelial surfaces detailed above, the 'wall' of the vesicle remaining for a time in the cell body.

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Burrowing of the Lugworm

In his recent letter in *Nature*[1], Wells gives an interesting account of the movements and action of the proboscis of the lugworm and of the part that it plays in burrowing. He considers that its movements alone are sufficient to account for this activity, which is chiefly due to the diverging teeth of the buccal mass scraping away soil particles in the line of advance. He appears to consider that the physical properties of the soil are of no direct importance to burrowing, which he likens to that of a "digging rabbit".

But it appears to us that the mode of action of the proboscis described by Wells is in no way at variance with our thesis, namely, that the thixotropic properties of the soil must be taken into account to explain satisfactorily the burrowing of the lugworm, and probably that of other animals living in a similar habitat. The exact movements of the proboscis, interesting though they are in themselves, are but a means of softening the soil in the line of advance. That a mere scraping away of sand particles is insufficient to account for the burrowing of the creature is shown by the results of other experiments (in the press). These indicate that the thixotropic state of the muddy sand which we studied is dependent upon the water content, and if this is reduced below a certain value (about 25 per cent by weight of water in the whole mass) the ability of the sand to become fluid on agitation is so diminished that lugworms cannot burrow into it. Yet, if we understand Wells' argument correctly, there should be nothing to prevent lugworms from burrowing even into perfectly dry sand. This they cannot do, nor, in fact, into sand which is not fully saturated with water.

Another aspect which is accounted for by the thixotropic behaviour of the sand is the construction by the worm of a *permanent* L-shaped burrow, as described fully by Wells[2]. This permanence could be accounted for by the rapid setting of the sand, as soon as the movements making the burrow have ceased. Again, it can be assumed that the downward-moving column of sand filling the headshaft is produced by movements which are effectively similar to those by which the burrow was made in the first place.

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The Cellulose of Marine Algæ

THE term 'algic cellulose' was applied by Stanford[1] to an insoluble residue obtained from seaweeds after the removal of algin, and many workers have assumed that this material is identical with the cellulose of land plants. Although denied by some[2], this view has been supported by Kylin[3] on the evidence of the colour reaction with iodine and sulphuric acid, and by Russell-Wells[4], who also demonstrated the solubility of the material in cuprammonium hydroxide and prepared an acetate.

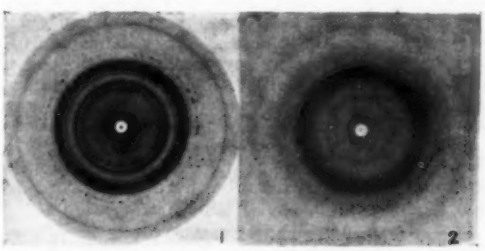
Dillon and O'Tuama[5] obtained a sugar by hydrolysis from which they prepared glucosazone and showed also that 'algic cellulose' was not a mannan. It was also converted into a viscose and into chloroform-soluble acetyl and methyl derivatives.

From these qualitative tests, therefore, the possibility exists that 'algic cellulose' is similar to cotton cellulose; but no evidence is available to show either that the substance is built up entirely from glucose residues, or that the fundamental 1,4-β-linkages are present. The problem has now been re-investigated under the auspices of the Scottish Seaweed Research Association.

Algal celluloses have been prepared from *Laminaria Cloustoni*, *L. digitata* and *Fucus vesiculosus* by a method based on the A.O.A.C. (Washington) crude fibre determination[6]. The products gave the characteristic blue colour with iodine–zinc chloride, and dissolved readily in Schweizer's reagent. Fluidity measurements[7] gave a value of *c.* 40 poises^{-1} and indicated considerable degradation in comparison with cotton cellulose (*c.* 2 poises^{-1}); a control experiment showed that this high fluidity was due mainly to the rather vigorous treatment used in the isolation, since the fluidity of cotton cellulose rose from *c.* 2 to 28 poises^{-1} when treated similarly.

Hydrolysis to glucose (yield 80 per cent of the theoretical, cf. 88 per cent from cotton cellulose) was carried out by the method of Monier-Williams[8], the sugar being estimated both polarimetrically and by Somogyi's[9] method before and after treatment with yeast[10]. No other reducing sugars could be detected, and this was confirmed by the paper chromatogram. Glucosazone was isolated in the usual way.

The algal cellulose was converted into cellobiose octa-acetate[11] (yield, 31 per cent), m.p. 224°, not depressed on admixture with an authentic specimen, $[\alpha]_D^{20°} + 40°$ (in chloroform). This is strong presumptive evidence that 1,4-β-linkages are present, and further confirmation was obtained by periodate oxidation. The course of this reaction was the same as that followed by cotton cellulose, 1·02 mol. of sodium periodate being consumed per $C_6H_{10}O_5$ unit (constant after seven days). The possibility of the existence of 1,3- and 1,6-linkages is thus negatived, since in the former case none, and in the latter two, molecules of $NaIO_4/C_6H_{10}O_5$ would be required, apart from the requirements of the terminal groups.



X-ray diagrams of (1) algal cellulose from *L. Cloustoni*. (2) material regenerated from (1) after dissolution in cuprammonium hydroxide

Oxidation with potassium periodate[12] and titration of the formic acid released (fourteen days) gave a result corresponding to a chain of *c.* 160 glucose units. This is much less than the value reported for cotton cellulose, but is explained by degradation during isolation. This result also disposes of any possibility that significant numbers of glucose residues are united in the polysaccharide by 1,6-linkages.

Through the kindness of Prof. W. T. Astbury, the X-ray diagrams of an algal cellulose prepared from *Laminaria Cloustoni* (Fig. 1) and of the material regenerated from *A* after dissolution in cuprammonium hydroxide (Fig. 2) have been investigated. *A* shows the characteristic pattern of normal cellulose and *B* that of 'hydrate' cellulose.

This result, taken in conjunction with the chemical evidence outlined above, makes it certain that algal cellulose is fundamentally similar to the cellulose of land plants, although, as with the cellulose from different plants, it would be unwise at present to

assume that all celluloses are identical in every respect.

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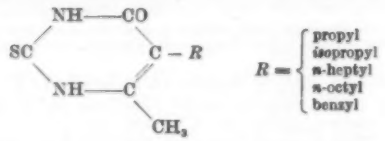
Effect of 5-Alkyl (Benzyl) Derivatives of 2-Thio-4-Methyl-Uracil on the Thyroid Gland and the Bone Marrow in Rabbits

H. Cullumbine and M. Simpson[1] have reported the results of their investigations on the activity of several derivatives of thymine (5-methyl-uracil) having an antithyroid property and a stimulating action on the bone marrow. These researches were based on the assumption that if thymine, according to Spiess, Jacobson and Williams, possesses a therapeutic value in the treatment of pernicious anæmia, its thio-derivatives should have a similar property with the simultaneous antithyroid activity. It is known that one of the greatest disadvantages of antithyroid drugs now being used is their toxic effect on the functioning of the bone marrow. The quantitative changes of reticulocytes and leucocytes in normal and splenectomized rabbits after a parenteral treatment with the compounds being tested were the basis of Cullumbine and Simpson's investigations.

The thiouracil derivatives synthesized by me in the Biological Institute of the University of Kraków possessed various hydrocarbon radicals (R) in position 5 beside the methyl grouping in position 4.



These compounds were examined biologically in regard to their action on the histological picture of the thyroid gland and to their influence on the functioning of the bone marrow. The criterion of the latter in my work was the number of white blood cells in 1 mm.[3]. The animals used were white rabbits about eight weeks old. All the compounds tested were given by mouth in equal dosages, once daily and for equal periods, to facilitate the comparison of the results obtained. The animals were treated in three groups: group (I), 9 days with 50 mgm. a day; group (II), 9 days with 50 mgm. a day and the following 5 days with 100 mgm. a day; group (III), 9 days with 50 mgm. a day and the following 9 days with 150 mgm. a day. In this way the following compounds were tested biologically: 2-thio-4-methyl-uracil; 2-thio-4-methyl-5-propyl-uracil; 2-thio-4-methyl-5-*n*-heptyl-uracil; 2-thio-4-methyl-5-*n*-octyl-uracil; 2-thio-4-methyl-5-*iso*propyl-uracil; and 2-thio-4-methyl-5-benzyl-uracil.

The first compound (May and Baker, Ltd.), at present widely used in the treatment of all forms of thyroid hyperfunction, was used as a standard preparation for comparison purposes. The results are given in the accompanying table.

Name of compound	Average percentage change in white blood cell count	Histological activity
2-Thio-4-methyl-5-propyl-uracil	−30	+++
2-Thio-4-methyl-5-*n*-heptyl-uracil	+64	no effect
2-Thio-4-methyl-5-*n*-octyl-uracil	+66	no effect
2-Thio-4-methyl-5-*iso*propyl-uracil	+52	+
2-Thio-4-methyl-5-benzyl-uracil	+15	+
2-Thio-4-methyl-uracil	−28	++++

Comparing the results, it is clear that the greater the number of carbon atoms in the *n*-radical linked with position 5, and consequently the larger the molecular weight of the whole compound, the weaker its antithyroid activity and the greater the stimulating effect on the bone marrow. The decrease of the antithyroid activity in this group of derivatives is, I think, connected with the increase of the molecular weight of the compounds, and consequently with decrease of the percentage of sulphur in the molecule.

In the second group of compounds tested there is an interesting difference between the 2-thio-4-methyl-5-propyl-uracil and 2-thio-4-methyl-5-*iso*propyl-uracil. The former exerts a marked influence on the function of the thyroid gland and an inhibiting one on the bone marrow, whereas the latter with its small effect on the thyroid gland brings about a rise of the white blood cells count of about 52 per cent.

Of the aromatic derivatives of 2-thio-4-methyl-uracil only the benzyl compound was tested; it was found to be ineffective as regards both the thyroid and the bone marrow.

These results show that the pharmacological action of these compounds depends not only on the number of the carbon atoms but also on the configuration of the radical linked with position 5. Further derivatives of this type are being prepared and tested.

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Role of Gastric Urease

In a previous communication[1], we were able to confirm that urease is present in the gastric mucosa and, to some extent, in the duodenal mucosa. It was pointed out that the amount of the ferment present in the whole stomach of an animal is sufficient to release enough ammonia from urea to neutralize large amounts of hydrochloric acid.

We suggested previously that urease might be concerned with the protection of the superficial gastric mucosa and the neutralization of hydrochloric acid, a view of its possible purpose which has also been advanced in the past by Luck[2], Linderstrøm-Lang and Ohlsen[3] and others. No direct experiments on this point were ever apparently made. If the concentrations of the substrate, urea, were changed,

presumably there might be more ammonia formed. In a series of normal student subjects we have compared the response of the stomach to histamine stimulation when given either without or with urea administered orally. The results are summarized in the accompanying table. It should be emphasized that all the urea solution was removed as the first post-histamine specimen was being removed, and, of course, that in the non-urea series a control solution was administered at zero time.

Mean maximum secretory response of 14 normal human stomachs to histamine acid phosphate (0·1 mgm./10 kgm.) without and with 15 gm. urea given at time of injection

Hydrochloric acid (m. eq.)				Ammonia-nitrogen (m. eq.)				
Non-urea		Urea		Non-urea		Urea		Blood urea change (mgm. per cent)
Fasting	After histamine	Fasting	After histamine	Fasting	After histamine	Fasting	After histamine	
5	60	6	27	9·36	9·80	7·99	36·54	29 → 41

These results are qualitatively similar in a limited series of gruel test meals or insulin test meals. The invariable result is a reduction of hydrochloric acid only variable in degree. It might be noted that even at the height of ammonia release into the stomach, the degree of neutralization observed could not always be explained on the basis of intra-gastric ammonia alone. The maximum increase in blood urea in these cases falls almost within the range noted after a meal (cf. Conway, O'Connor and O'Donovan[4]). We are, as yet, not clear how the precise effect of the urea rise is brought about, though the neutralization view is most favoured. There is a possibility that the increased urea inhibits the oxyntic cells. Against this there is the observation that the histamine volume response does not appear to change, suggesting the effect is eventually increased neutralization rather than diminished formation.

A calculation can be made as to the amount of urea which would be required to neutralize an average amount of acid secreted in the stomach. Urease releases 2 mol. of ammonia from 1 mol. of urea. At *p*H 6, 80 per cent of the ammonia nitrogen released from urea by urease will be dissociated from any HCO_3 compound; at *p*H 5 about 95 per cent will be dissociated. 300 mgm. urea would be required to neutralize 100 ml. *N*/10 hydrochloric acid. It is known that there may, at least in extreme circumstances, be quite a large urea A/V difference in the stomach (cf. Vladesco *et al.*[5], who were only concerned with the problem of urea excretion in uræmia). No figures are as yet available for animals with a more normal blood urea, nor are there any reliable data on the blood flow in the stomach. Hanke[6] states that 60 ml. of gastric blood flow is required for the production of 1·1 ml. of gastric juice. If the same flow exists during the time required to neutralize this same acid (assuming it to be *N*/10) an A/V difference of 5·5 mgm. per cent urea would be required. Obviously the addition of urea would facilitate this effect, though how it is controlled we do not know.

We have no evidence as to the fate of any ammonia retained inside the gastric mucosal wall, but have not been able to detect any urea-forming system. The use of urea in the study and treatment of the peptic ulcer has been initiated and the results to date are most promising.

One of us (O. F.) wishes to acknowledge the receipt of grants from the Medical Research Council of Eire. We would also wish to acknowledge our indebtedness to Prof. E. J. Conway for many helpful discussions.

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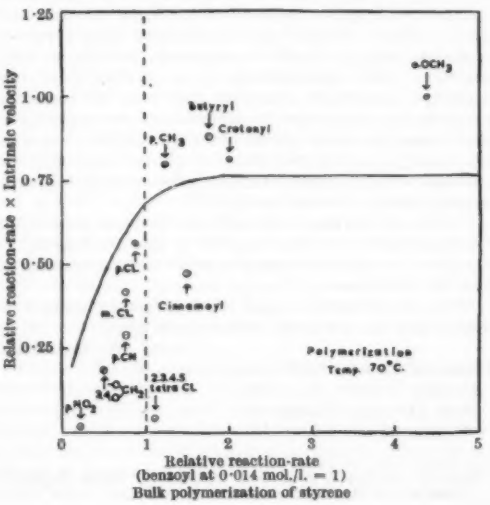
Radical Reactivity in the Initiation Reaction of the Polymerization of Styrene

FREE radicals are known to have widely varying activities, as shown by the studies on the reactions of peroxides with various organic compounds by Kharasch[1] and by studies on copolymerization by Mayo *et al.*[2]. It is possible from a study of the catalysed polymerization of vinyl compounds to obtain information on the activity of the radicals initiating the polymerization. Results are here given on the polymerization of styrene using various types of peroxide catalyst. As an empirical and arbitrary measure of the activity of the catalyst, the product of the rate of polymerization and intrinsic viscosity of the polymer has been taken. (The detailed justification for holding this to be a measure of the catalyst activity will be given on another occasion.)

In the accompanying graph are shown the results obtained with a few diacyl peroxides. The product of $-\frac{dM}{dt} \cdot (\eta)$ is plotted against $-\frac{dM}{dt}$ (the velocities of reaction are taken relative to that of benzoyl peroxide at 0·014 mol./l. concentration; the other peroxides examined are at the same concentration).



The continuous line shows the value of $-\frac{dM}{dt}.(\eta)$ for benzoyl peroxide over a wide range of concentrations. This has been included as it shows that with 'good' catalysts and fairly high catalyst concentrations the activity is independent of changes of catalyst concentration. This point is important since all peroxides decompose at different rates; hence the comparison has been made at equal rates of polymerization. The fall in the curve at lower concentrations is probably due to the more noticeable effect of transfer reactions. (As at this stage the results are purely comparative, it is not considered necessary to use the power relationship which has been established between (η) and the molecular weight; the constancy of the product of the reaction-rate and intrinsic viscosity over a wide range is fortuitous.)

The activity, according to this point of view, is shown by the values of the ordinates for the various catalysts relative to the standard catalyst, benzoyl peroxide. The position on the abscissa is of less importance, though in some cases it gives an indication of the rate of decomposition of the catalyst. The results shown, which are mainly obtained from substituted benzoyl peroxides, support the view that electron-attracting substituents give radicals of low activity, particularly when this is supplemented by the mesomeric effect. On the other hand, electron-repelling groups increase the activity of the radical.

In the case of alkoxy benzoyl peroxides, the mesomeric effect outweighs and reverses the inductive effect, consequently the activity of the radical is high. (This result is supported by U.S.P. 2,419,347, claiming high catalytic activity for *o*-alkoxy benzoyl peroxides.) However, di(3-4-methylene dioxybenzoyl) peroxide has a low activity, suggesting that the observed effect is purely inductive. Halogens have similar activities with the same orientation: the two results shown for di-*p*- and -*m*-chlorobenzoyl peroxides are in the expected positions. (Many of the results are in a similar order to those found for the dissociation constants of the substituted benzoic acids. In addition, an 'ortho' effect is shown by all ortho-substituted benzoyl peroxides.) Alkyl groups, as would be expected, increase the activity; but there is little difference between the effects of different alkyl groups. A result for an aliphatic acyl peroxide is given, and, as would be expected, this shows high activity. The introduction of a double bond (di-crotonyl peroxide) increases the rate of reaction, possibly by an increase in the rate of decomposition, and causes a slight fall in activity. Replacement of the methyl in this peroxide by phenyl, however, in dicinnamoyl peroxide, stabilizes the radical, which is consequently of lower activity.

These results seem to indicate that an important characteristic of a free radical is the availability of the free electron for reaction with the π-electrons of the double bond.

This work forms a part of a larger investigation which will be given in detail elsewhere.

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Transformation of Frequency Distributions

Frequency distributions of numbers of eggs, insects, spores, or other biological entities are descriptive of discrete variation, and can never be represented *exactly* by a normal distribution or by any other distribution of a continuous variate. Nevertheless, when the number of observations and the range of variation is large, such distributions may often be *adequately* represented by a continuous distribution. Experience has shown that transformation of discrete counts to a scale of $\sqrt{n}$, $\log n$, or $\log (n + 1)$ may considerably assist the representation by a normal distribution.

The device of plotting the cumulative distribution in probit units against a proposed square root or logarithmic scale of counts, as suggested by Gaddum[1], is useful as a rapid test of whether or not the right normalizing transformation has been found: if the distribution is effectively normal on the transformed scale, the probits will be linearly related to the counts. Spiller[2] has recently commented on this procedure. He has stated that statistical analysis in terms of this linear regression seems preferable to argument from the parent distribution, but that methods of calculating regressions and variance do not appear to be available.

In all uses of probit methods, however, the parent distribution must be kept in mind. The standard methods of calculation associated with probit analysis[3] have been devised for data in which the cumulative distribution is estimated directly from the observations, and they are clearly not appropriate here. The regression equation for a diagram such as that drawn by Spiller is, in fact, a line which attains a probit value of 5·0 at the mean value of the sample (on the transformed scale), and which has a slope equal to the reciprocal of the standard deviation of the sample; an application of statistical theory to the problem of estimating this line would show that the parameters of the line were to be obtained from that mean and standard deviation. As Gaddum has stated, "The best estimates of the mean and standard deviation will be obtained by applying the ordinary methods directly to the transformed observations".

Some idea of the values of the parameters may be formed by measurement of the diagram. For example, Spiller's line *B* has a value of about 0·70 for $\log (n + 1)$ at a probit of 5·0, and an increase of unity in $\log (n + 1)$ corresponds to a probit increase of about 1·9. Hence the distribution of $\log (n + 1)$ may be regarded as approximately normal, with mean 0·70 and standard deviation 0·53 (= 1/1·9); these compare with values, calculated from Spiller's table, of 0·774 for the mean and 0·487 for the standard deviation. The size of the standard deviation relative to the mean suggests that agreement with a normal distribution cannot be very close (though it may be good enough for comparisons between samples to be made with the aid of normal distribution theory), and comparison of the frequency polygon with the calculated distribution would confirm this. The probit diagram may indeed be deceptive for data of this kind, since considerable deviations from normality are not always apparent by inspection of it.

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THE INTERNATIONAL ASTRONOMICAL UNION

At the seventh General Assembly of the International Astronomical Union which was held at Zurich during the week beginning on August 11, more than three hundred astronomers from thirty countries met (in many cases for the first time for ten years) to discuss their past results, their current problems and their future plans. The machinery of international collaboration, kept going during the War by the good offices of astronomers in neutral countries, had been overhauled at a meeting of the Union's Executive Committee at Copenhagen in the spring of 1946; and it was largely because of the spadework put in by that committee, then and since, that the full Assembly could get on with its business so expeditiously at Zurich. The Federal Institute of Technology was kindly made available to delegates throughout the week. The hundred sessions held by the forty commissions into which the Union is subdivided put no severe tax on the accommodation available, and the many mixed commission meetings, colloquia and informal lectures, though they were well attended, could always find an auditorium of ample size. It was evident that behind the smooth functioning of the local arrangements, which included (as well as the formal business) a full programme of social events and sightseeing trips for delegates and their guests, lay a tremendous amount of hard work by a most efficient organising committee, headed by Prof. Waldmeier, director of the Zurich Observatory.

After an inaugural general assembly at which warm welcomes were accorded the delegates by the civic authorities and by the Swiss National Committee of Astronomy, and were responded to by the president of the Union, Sir Harold Spencer Jones, the members devoted a short session to administrative business. The financial load on the Union has been considerably eased by a decision of Unesco to support many bodies, such as the Bureau International de l'Heure and the International Latitude Service, the world-wide scope and general scientific value of which deserve such support. The Union in its turn eased the financial burden on its less wealthy adherent countries by altering the system of paying dues. Instead of paying, as now, on a *per capita* basis, countries will in future be classified (on their own proposal, ratified by the Executive Committee) into eight categories, each paying different subscriptions. By this modification countries with large populations, such as India or China, will be relieved of the necessity of paying dues out of proportion to the extent to which astronomy has developed within their borders.

The next five working days were devoted to purely scientific matters. Discussion varied, as always, from prepared contributions to a symposium attended, perhaps, by a hundred delegates, to fierce wrangles around a table on some obscure technical point between the only three people in the world aware of its import. At the commission meetings themselves, the business was partly organisational and partly scientific, the proportion varying with the subject-matter of the commission. At one end of the building a handful of delegates might be revising the code for astronomical telegrams or the list of standard astronomical notations, while at the other a no less earnest group would be discussing the constitution of interstellar matter, or the emission spectrum of the night sky.

In the commissions concerned with positional astronomy, modern methods for improving meridian work were discussed. The Russians have successfully experimented on photo-electric recording of transits of the brighter stars, while the Washington transit circle is now fitted with cameras which record all readings photographically so as to reduce fatigue in the observers and eliminate erroneous logging of the results. New instruments are being designed, some of them (notably those at Greenwich) based on new principles chosen so as to eliminate many of the most troublesome errors that beset meridian work. Photographic astrometry proceeds apace with wide-angle lenses and now with Schmidt cameras, and the application of punched-card methods to repetitive computation is being followed by the development of automatic plate-measuring devices which feed measured co-ordinates direct to the mechanical computers. Inconsistencies recently found in the adopted system of the fundamental astronomical constants are to be attacked by a research team in the United States, and authors are urged not to make *ad hoc* alterations pending the report of this team.

The solar commissions were faced with tremendous advances in our knowledge since the previous meeting, at Stockholm in 1938. Solar-terrestrial relationships, if little better understood, are now reduced to some sort of order since the importance of solar flares and active coronal regions became clear; the coronal spectrum is no longer a mystery, even if the corona still is; and on the instrumental side astronomers now have the help of prominence cinematography, the Lyot polarization filter, and the V2 rocket for exploring the sun's ultra-violet spectrum. But with these advances have come new problems; and much time was taken up in discussing solar radio noise, corpuscular emission from solar flares, and chromospheric structure. Nor have all the long-standing problems been cleared up, as was shown when two of the liveliest controversies of the week developed around the supposed variations in the solar constant and the magnitude of the sun's magnetic field. There was a powerful appeal for further direct observations to confirm the Smithsonian measurements of the solar constant when reports of indirect checks (via the brightness of the moon and of Uranus) revealed conflicting results. As for the sun's magnetic field, so much recent work has been based on the classical results at Mt. Wilson that there was something of a sensation when it was announced that both Mt. Wilson and Hamburg Observatories had recently failed to detect the field with apparatus that had apparently confirmed its presence only a year or two ago. Whether this failure is due to a real change in the magnitude of the field or to an under-estimate of the size of the accidental errors of observation did not emerge; but a suggestion that the matter might be settled by measuring the polarization of the sun's radio emission from its north or south hemisphere during an eclipse was seized on as a hopeful way out of the quandary.

In the field of research on nebulæ, observers and cosmologists met on common ground. Recent spectrophotometric work has shown that the more distant nebulæ are redder than can be accounted for by the red-shift in their spectra, that is, the colour indices of the nebulæ increase with distance. This is conceivably an evolutionary effect: for if, as is

currently believed, the red supergiant stars in the nebulæ exhaust their internal store of nuclei available for energy generation more rapidly than other stars, the distant nebulæ, which we see in their youth, will indeed be redder than the older ones in our neighbourhood, from which the red giants have faded. But whatever the explanation, this reddening must seriously affect those nebular counts to limiting magnitudes on which depend our present observational tests of various world-models. An interesting but inconclusive discussion took place on whether the classification sequence of the external galaxies is also an evolutionary sequence; and if it is, whether the sense of evolution is not towards rather than away from the elliptical forms. The cosmologists present carried the observers with them in an appeal to present observational results in a form which would facilitate rather than preclude a comparison of the different theories of world structure; in particular, to refrain from applying dubious 'corrections' for cosmological effects which are based on a particular model and therefore exclude others from proper consideration.

In a crowded symposium on infra-red spectrophotometry, recent results obtained with photoconductive lead sulphide cells were presented. Perhaps the most spectacular are: the identification of the infra-red spectra of the Martian polar caps and of the rings of Saturn with reflexion spectra from hoar-frost deposited on solid carbon dioxide; the suggestion that the green areas on Mars are due not to vegetation but to lichens devoid of chlorophyll; and the discovery of methane high in the earth's atmosphere from telluric bands at 3·4 μ and 1·6 μ in the solar spectrum.

Other well-attended meetings considered the spectral sequence and its anomalies (perhaps the most important paper here was a Russian one showing that a variety of observational data could be explained if interstellar matter is concentrated into small discrete clouds about 10 parsecs in diameter), the outer layers of the sun, and current progress with the 200-in. telescope. It seems that after a little preliminary trouble with the mirror supports, all goes well with the latter. The figure is approaching perfection, which the opticians define as "correct to 1/10 wave", and the light-grasp is up to expectations.

Animated discussions took place when the commission on international observatories met. Sharp cleavages of opinion emerged on the relative value of the various proposals which had been made, all designed to show that astronomy at least can override political boundaries. It was finally decided to proceed with all the immediately practicable parts of the schemes, including plans for establishing an international telescope in the southern hemisphere, an international astronomical laboratory in Europe (including a library and optical shops and a computing centre), and an international travel fund for facilitating exchange of astronomers.

The meeting reached its climax with a conference on the cosmic abundances of the elements. Since the 1938 meeting a measure of agreement has been reached on the nuclear reactions controlling energy generation in the stars, and interest now centres on the allied problem of elemental abundances. As a result of the present conference, it is now clear that no significant differences of abundance exist between the sun, the main-sequence stars and even the planetary nebulæ and interstellar matter, and that the proportions of the elements found in the earth's crust and in meteorites differ from the cosmic proportions only in physically explicable ways. The high-luminosity stars, however, lie on a mass-luminosity curve appropriate to a much higher mean molecular weight than the sun's; and it seems likely that, as was expected from their high rate of radiation, these giants have already burned up a considerable part of their hydrogen content. While discrepancies do undoubtedly exist in certain celestial bodies, it would be fair to say that the observed abundances do fit present conceptions reasonably well. The next move is to explain how the present abundances arose, and some steps have already been taken in this direction.

At the concluding general assembly some general resolutions were passed, the lists of members and of commissions were revised and new officers were elected. The incoming president is Prof. B. Lindblad, of Stockholm; the new general secretary is Prof. B. Strömgren, of Copenhagen. No decision has yet been reached on whether to hold the next meeting, in 1951, at Leningrad or Pasadena. With a final vote of thanks to its Swiss hosts for making possible a most successful meeting, the seventh General Assembly of the Union was declared closed on August 18.

VITAMIN C IN POTATOES

By Dr. FRANK WOKES
Ovaltine Research Laboratories, King's Langley, Herts
AND
GORDON NUNN
Oakley Training College, Cheltenham, Glos.

THE vitamin C content of potatoes is known to diminish steadily during the autumn and winter, so that their contribution towards the national requirements of this vitamin is considerably diminished. The average content of vitamin C in *raw* potatoes, as found by different workers, has been summarized by Lampitt, Baker and Parkinson[1] and is indicated by the shaded area in Fig. 1. The

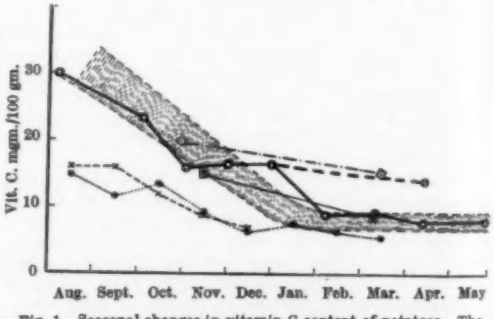


Fig. 1. Seasonal changes in vitamin C content of potatoes. The shaded portion represents average content in raw potatoes in different seasons as summarized by Lampitt, Baker and Parkinson. Results on raw potatoes stored in clamps indicated thus:
Lampitt, Baker and Parkinson (1945), □——□
Baker, Parkinson and Lampitt (1946), ◇—·—◇
Wokes and Nunn (1948), potatoes in clamp, ○——○
Potatoes removed from clamp to dry room, ○— — —○
Results on cooked potatoes indicated thus:
Olliver (1943), ×- - - -×
Thompson (1944), •.....•

vitamin C content of *cooked* potatoes, as found by different workers[2,3], is indicated in the same figure by dotted lines, and will be seen to be less than that of the raw potatoes but to show a similar decline in the latter part of the year. Certain workers[4] have found that in raw potatoes stored in clamps the vitamin C content does not always fall so steeply as would be expected from the average figures. No convincing evidence has been forthcoming to show that this was due to temperature changes. The question how to diminish, and if possible prevent, this loss of vitamin C is therefore not yet satisfactorily answered.

In the course of some storage experiments on potatoes which we have been carrying out recently, we have made some observations which may perhaps be of interest. The potatoes we used (Kerr's Pink) were grown in Cheltenham and stored in an experimental clamp, samples being withdrawn at regular intervals for testing. Results obtained on these potatoes are indicated in Fig. 1 and show that, after the usual drop in the autumn, the average vitamin C content became steady in three batches taken during November and December, but fell again in January, February and March. These results are based on duplicate assays on more than a hundred separate potatoes, enough being taken to ensure that the alterations in the slope of the curve at the end of October and at the end of December were highly significant.

When looking for a possible cause for the unexpected stability of the vitamin experienced by ourselves, and occasionally by other workers[4], we first considered the storage temperature. Daily records of the maximum and minimum temperature in the storage clamp did not provide the explanation we were seeking. Moreover, in some of our potatoes stored in the refrigerator we experienced a greater loss of vitamin than in others of the same variety of potatoes stored at higher temperatures (see table). Taken in conjunction with the findings of previous workers, who detected no difference in the rate of loss at different storage temperatures from 3° to 31° C., our results seem to show that storage temperature *per se* is not a decisive factor.

Effect of storage conditions on rate of loss of vitamin C in potatoes

Storage conditions	% Loss	No. of weeks	% Loss per week
Closed containers			
at 4–5° C.	14·1*	10	1·4
at 27° C.	20*	7	2·9
Open to air			
(L) at 30° C.	41	9	4·6
at 4–5° C.	75†	20	3·8
(L) at room temperature (20° C.) in dark	32	6	5·0
	26	9	2·9
(L) at 31°C. in dark	23·5	5	4·9
	23·5	9	2·6

This table includes results obtained by Lampitt and his colleagues (marked L).
*Indicates less significant ($p = 0·1$–$0·2$).
† Indicates highly significant ($p = 0·01$).

We next considered the effect of atmospheric moisture. Our potatoes, like those of Lampitt and his colleagues, also stored in the refrigerator and referred to in the table, were exposed to air and therefore to a higher relative humidity than the potatoes stored at higher temperatures. It seemed to us feasible that the absorption of moisture from a more humid atmosphere might increase the tendency to form sprouts and thus use up some of the vitamin C in the potato. Rainfall records for the area in which our experimental clamp was situated showed that there was, in fact, very little rain during the period November–December, when the vitamin C content of the potatoes remained constant, but much more rain in January and February, when the vitamin C content fell. As a further test of this hypothesis, we examined in April some of the potatoes which had been taken for seed purposes from the clamp at the beginning of January and since stored in a dry shed. The vitamin C content of these potatoes was significantly higher than in similar potatoes stored in the clamp during this period; for example, $13·9 \pm 0·4$ as compared with $7·7 \pm 0·4$ mgm./100 gm. When these seed potatoes were stored in the same humid atmosphere as the main stock for a few days, they began to sprout and their vitamin C content fell to $8·1 \pm 0·9$ mgm./100 gm. (the second figure given above is the standard deviation of the mean).

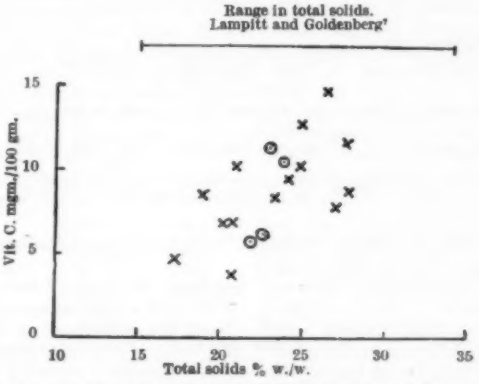


Fig. 2. Relation between vitamin C content and total solids in Kerr's Pink potatoes grown in Cheltenham in 1947 and stored under different conditions; ×, in experimental clamp; ⊙, in refrigerator in sealed bottles

If the onset of sprouting, with consequent utilization of vitamin C, depends on the moisture content of the potato, some degree of correlation might be expected to occur between the total solids of individual potatoes in a given batch and their vitamin C content. Although the season was by this time too far advanced to obtain very convincing figures, we attempted to investigate this question, and think that our data, summarized in Fig. 2, at least suggest the possibility of such a correlation. We hope that publication of these preliminary findings may stimulate other workers to study this problem, the solution of which should benefit the diet of the nation.

We are indebted to Misses Finnegan, Morphet and Raynor and to Mr. D. B. Kingston for assistance, and to Glaxo Laboratories, Ltd., for the loan of a Waring blender used in preparing some of the extracts.

[1] Lampitt, L. H., Baker, L. C., and Parkinson, T. L., *J. Soc. Chem. Ind.*, **64**, 22 (1945).
[2] Olliver, M., *Chem. and Ind.*, **62**, 146 (1943).
[3] Thompson, J. C., *Proc. Nut. Soc.*, **3**, 147 (1944).
[4] Lampitt, L. H., Baker, L. C., and Parkinson, T. L., *J. Soc. Chem. Ind.*, **64**, 12 (1945).
[5] Lampitt, L. H., Baker, L. C., and Parkinson, T. L., *J. Soc. Chem. Ind.*, **65**, 428 (1946).
[6] Lampitt, L. H., private communication.
[7] Lampitt, L. H., and Goldenberg, N., "The Nation's Food" (Soc. Chem. Ind., London, 1946).

ORIGIN OF LANGUAGE

By Prof. ALEXANDER JÓHANNESSON
University of Iceland

In articles in *Nature*[1], I have set out the conclusion that a great part of human speech originated in the speaking organs' unconscious imitation of the gestures of the human body, especially the hands. The three articles dealt only with Ide. and Hebrew (as representative of the Semitic group). I have continued my researches and this time chosen the sounds *l* and *r*, which I have systematically investigated in Ide., Hebrew, Archaic Chinese, Polynesian, Sumerian and partially in Greenlandic.

In all these 'unrelated' languages the sounds *l* and *r* show a double origin: (1) that of a Nature sound (especially where *l* and *r* form the beginning of a syllable, or in the connexion vowel + *l* or *r*, but sometimes also in the combination consonant + vowel + *l* or *r*), and (2) that of a different (gestural) sound (mostly in the connexion consonant + vowel + *l* or *r*, but even vowel + *l* or *r*) as spontaneous imitations of the speaking organs to express the idea of the form or shape of things in Nature or to designate a movement.

The investigation shows that the most remarkable meanings of roots with the Nature sounds *l* and *r* (marked as *l'* and *r'* to distinguish them from l^a and r^a, which mainly are a means of designating the shape or form or a movement, cf. above) are: (1) sound; (2) light, colour; (3) water; (4) to break, scratch, etc. 'to smash, to tear, to scratch', etc., shows that in those roots the *l* and *r* represent a hard sound (as also in some cases of Nos. 1 and 2).

More interesting is it to see how the 'unrelated' languages imitate the shape or form of things or movements. In the combination consonant + vowel + *l* or *r*, or vowel + *l* or *r*, we see how the idea of 'round, vaulted, curved, twisted', etc., or the idea of 'to rise above, to grow, to lift, to move', etc., came into existence by the speaking organs' spontaneous imitation of a curved form or movement.

The importance of comparing the roots in different languages may be seen by tabulating the number

	Ide.	Hebrew	Arch. Chin.	Polynes.	Sumerian
Examples with l:					
1. Sound	*lēu-* (Ags., *lēop*, 'song')	*lw-n*, 'to mutter'	*liw-ər*, 'eulogy'	*leo*, 'the voice, speech'	*lu-ga*, 'to scold'
2. Light, colour	*leuq* (Lat., lux)	*lw-ḥ*, 'to shine'	*luk*, 'to look carefully' (*liuk*, 'green')	*rakeraka*, 'a torch' (in P. *r* and *l* interchange)	*luġ, laġ*, 'light'.
3. Water	*leiqu-*, 'wet' (Lat., liquor)	*lḥ-ḥ*, 'be wet'	*lia*, 'thin wine'; *log*, 'rain water'	*rewa*, 'melt, become liquid'	*li-*, 'fat'; *lâ*, 'muddle, disturb the water'.
4. To break, scratch, etc.	*lem-*, 'to break' (Old-Bulg. *lomĭ'ja*, 'to break')	*lm-d*, 'to stab'	*lâp*, 'to break'	*rumi*, 'to squeeze'	*laġ*, 'to strike'.
Examples with r:					
1. Sound	*rēu-*, 'to sound' (Old-Ind. *rāu-ati*, 'cries, sounds'	*rz-ḥ*, 'to cry'	the hard '*r*' does not exist	*rāra*, 'to roar'.	
2. Light, colour	*reg*, 'to colour' (Gr., *ῥεζω*)	*rah*, 'to see'		*ra*, 'the sun'	*ra*, 'shining'.
3. Water	*reg-*, 'wet rain' (Lat., *rigare*)	*rh-ṭ: rahaṭ*, 'water-pipe'		*rire*, 'deep water'	*ri*, 'to flow'?
4. To break, scratch, etc.	*reis-*, 'damage' (Old-Ind. *riṣyati*, 'damages')	*rz-ẓ*, 'to smash'		*raku*, 'to scratch'	*ri*, 'to throw down'.

Of Ide. and Hebrew roots with *r* according to their various meanings:

	No. in Ide.	No. in Hebrew
Sound	46	19
Colour	32	10
Water	19	14
To break, scratch	91	70
Round, vaulted, curved	103	26
To move, rise above	97	83
Total	388	222

To this may be added some other roots, especially with the meaning 'to cut' (Ide., 8 roots; Hebrew, 17) or 'to devour' or to be 'relaxed'.

As the roots with *l* have a similar extension to those with *r* we see that, in Ide. languages, the sounds *l* and *r* in the roots of approximately one word in three have more or less determined the meaning (the Ide. roots

	Ide.	Hebrew	Arch. Chin.	Polynes.	Sumerian	Greenl.
Round, vaulted, curved, twisted, etc.	*ḫel-*, 'to enclose, cover' (Lat., color)	*kl-l*, 'to bend, encompass'	*kl-ṣo*, 'round basket'	see under *r*	*gal* (*ga-al*) 'big'	*qal-aq*, 'ribbon'
	ḫer-, 'string, to plait'	*kr-r*, 'be round, turn'	*k'iər*, 'bow down (the head) to the ground'	*kara*, 'an old man' (bent by age, cf. Gr. *γεραιος*)	*gar*, 'to encompass'; *gûr*, 'to bow'	*qar-ajak*, 'bay, encircled by rocks'
To move, to rise above, to grow, to lift, etc.	*tel-*, 'to lift' (Lat., *tollo*)	*dl-g*, 'to jump'	*lia*, 'depart from'; *liər*, 'push away'	*tere*, 'to move swiftly'	*zal*, 'to extend' *sir*, 'be long, to remove'	
	reiq-, 'to arise' (Germ. *riegel*)	*rg-š*, 'turbulent movement'				

All these four subdivisions are closely related. It is an accepted theory that an impression on either the ear or the eye may give the same phonetical release (*Schall- und Lichtempfindung* in German handbooks)—presumably because they were originally symbolized by somewhat similar gestures. Thus Ide. *ghel*, 'to cry', and *ĝhel*, 'to shine', are related. No. 4, with the meaning number 2200), and that in more than 50 per cent (200 out of 388 for the sound *r*) all words containing in the roots the sounds *l* or *r* are of gestural origin. This fact might encourage philologists to scrutinize systematically all combinations of sound-groups in the roots as the most important means of solving the problem how man learned to speak.

[1] *Nature*, **153**, 171 (1944); **154**, 466 (1944); **157**, 847 (1946).

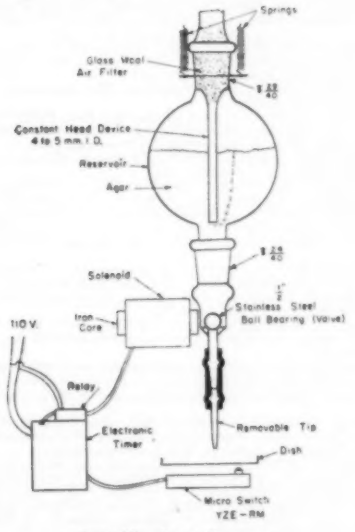
AN AUTOMATIC AGAR DISPENSER

By W. H. SCHMIDT*, M. D. REEVES†, FRANCIS J. CASTLE and R. G. BENEDICT

Fermentation Division, Northern Regional Research Laboratory‡, Peoria, Ill.

IN many laboratories various types of semi-solid culture media are routinely dispensed in Petri dishes for use in the study of micro-organisms.

The automatic agar dispenser described in this article was originally designed for rapid and reasonably accurate transfer of melted agar to plates for subsequent use in the assay of penicillin. A notice of this was published some time ago[1]. Because of the interest shown in the apparatus by visitors from other laboratories, it appears desirable to publish a more complete description which will be more widely available. A drawing of the apparatus is reproduced herewith.



Assembly of agar dispenser

In principle, the device is simple. It consists of a constant-head reservoir which empties through a modified solenoid valve connected with an electronic timer. The only part of the apparatus considered difficult to make is the glass seat for the ball valve. This seat should be flattened so that no leakage can occur when the stainless steel ball is in its normal position. When the micro switch is pressed, the solenoid must not lift the ball but roll it to one side. Any timer, either mechanical or electronic, which makes or breaks a circuit may be used, the accuracy of the device depending upon the accuracy of the timer. The size of the glass reservoir for holding the agar depends on the quantities to be dispensed. For routine plate-pouring (20 ml. per plate), we use a vessel with a total capacity of 2 litres. For dispensing smaller amounts of agar, such as those required for flooding assay plates (4 ml. per plate), a 500-ml. receptacle is used. A delivery tip with a much smaller opening is attached to this vessel.

Sterilization of the reservoir and valve in our Laboratory is effected by passing steam in at the top and permitting it to escape to a drain by raising the ball valve with a straightened paper clip inserted through a small opening in the rubber tubing. The constant-head device and delivery tip are sterilized separately in an Arnold steamer. Autoclave sterilization may be substituted when steam is not available on the laboratory table. To guard against the possibility of pressure developing in the reservoir during steam sterilization on the table, two steel springs, attached at the top of the standard taper (29/40) male joint, are clipped to loops at each end of a wire ring, shown at the top of the reservoir. Should the ball valve accidentally close during sterilization, slight steam pressure pushes the top male joint up to prevent breakage of the reservoir. In assembling the apparatus, we close this top joint with only moderate pressure and do not employ any lubricant. The lower joint standard taper (24/40) connecting the bottom of the reservoir with the glass assembly containing the ball valve is greased with a temperature-resistant chemically inert lubricant.

Data on accuracy of delivery are shown in the accompanying table. A 2 per cent agar medium was melted and cooled to 48° C. before transfer to the glass reservoir. The timer was set to deliver 20 ml. agar (ball valve opened and closed in 1·5 sec.).

Accuracy of delivery of automatic agar dispenser
Weight in grams of 20 ml. samples, reading down from left to right

20·91*	20·60	20·54	20·40
20·80	20·72	20·65	20·32
21·08	20·62	20·28	20·27
20·76	20·32	20·74	20·30 (last sample)
20·64	20·71	20·41	
20·82	20·71	20·35	* First sample

Average weight of all samples delivered was 20·63 gm. Extreme variations from the mean value were +0·45 gm. and −0·36 gm.

One operator is able to handle thirty plates within 2–3 minutes. The dispenser is much simpler and faster than agar delivery by pipette, and more accurate than pouring plates from tubes containing measured amounts of the materials.

[1] Schmidt, W. H., *Bull. Health Organ., League of Nations*, **12**, 259 (1945–46).

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‡ One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U.S. Department of Agriculture.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 6

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Dr. A. D. Buchanan-Smith: "Inheritance of Milking Capacity in Dairy Cattle".

UNIVERSITY OF LONDON (in the Department of Biochemistry, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. C. de Duve: "The Control of Carbohydrate Metabolism".* (Further lectures on Thursday, December 9, and Monday, December 13.)

UNIVERSITY OF LONDON (at the Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Mr. K. L. Little: "Education for International Understanding—Africa".*

SOCIETY OF CHEMICAL INDUSTRY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. H. Seligman: "Application of Radio-active Elements in Industry".

ROYAL INSTITUTE OF CHEMISTRY (at Norwood Technical Institute, Knight's Hill, London, S.E.27), at 7 p.m.—Dr. A. Albert: "Drug Action, Ions and Neutral Molecules".

Tuesday, December 7

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX, NORTHERN BRANCH (at the North of England Institute of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle-upon-Tyne), at 10 a.m.—Conference on "The Value of Organised Information Service to Industry, Commerce and Education".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. W. B. Douglas: "Maternity in Britain—the Results of a Social Survey".*

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting of the MEASUREMENTS and SUPPLY SECTIONS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Papers.

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. E. F. Edson: "Radiation Hazards and their Control".

SIR HALLEY STEWART TRUST LECTURE (at the Memorial Hall, Farringdon Street, London, E.C.4), at 6 p.m.—Prof. D. W. Brogan: "The Atomic Age—America as Atlas".•

Wednesday, December 8

PHYSICAL SOCIETY, COLOUR GROUP (in the Large Physics Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Scientific Papers.

MANCHESTER STATISTICAL SOCIETY (at the Reform Club, King Street, Manchester), at 5.30 p.m.—Air Vice-Marshal Donald Bennett: "Order in the British Air".

ILLUMINATING ENGINEERING SOCIETY (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6 p.m.—Reports and Discussion on the 1948 Meeting of the International Commission on Illumination.

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.30 p.m.—Mr. Longworth: "Functional and Performance Characteristics of Automatic Temperature Control".

Thursday, December 9

PHYSICAL SOCIETY (at the Laboratories of the Metropolitan-Vickers Electrical Co., Trafford Park, Manchester), at 9.45 a.m.—Scientific Papers.

LINNEAN SOCIETY OF LONDON (joint meeting with the ROYAL ENTOMOLOGICAL SOCIETY, at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "The Bearing of the Parasite-Host Relationship in Taxonomy" (to be opened by Mr. G. H. E. Hopkins, Dr. J. Ramsbottom and Dr. O. W. Richards).

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 5 p.m.—Discussion on "Colour Vision in Industry" (to be opened by Prof. W. J. B. Riddell, Prof. H. Hartridge, F.R.S., Dr. W. D. Wright and Dr. Leslie Norman).

CHEMICAL SOCIETY (joint meeting with the LOCAL SECTIONS of the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Lecture Theatre, The University, Manchester), at 6.30 p.m.—Prof. C. K. Ingold, F.R.S.: "Aromatic Nitration".

TEXTILE INSTITUTE, MIDLANDS SECTION (joint meeting with the COVENTRY TEXTILE INSTITUTE, at St. George's Hall, Nuneaton), at 6.45 p.m.—Mr. A. Y. Stirrat: "Increasing Production in the Textile Industry by Training and Production Study".

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Princes Gate, London, S.W.7), at 7 p.m.—Dr. R. H. Herz: "The Action of X-Rays and Electrons on the Photographic Emulsion".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (joint meeting with the AGRICULTURE GROUP, at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 7 p.m.—Dr. W. A. Sexton: "The Chemistry of Plant Growth Regulators".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Scientific Papers.

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGICAL PANEL OF THE FOOD GROUP (joint meeting with the NOTTINGHAM SECTION of the S.C.I., at the Nottingham Gas Show Rooms, Nottingham), at 7.15 p.m.—Mr. F. C. Bawden: "Some Properties of Plant Viruses".

CHEMICAL SOCIETY, EDINBURGH SECTION (joint meeting with the LOCAL SECTIONS of the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the North British Station Hotel, Edinburgh), at 7.30 p.m.—Dr. D. W. Kent-Jones: "Bread and its Influence on History".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. G. Crowden: "A Survey of Physiological Studies of Mental and Physical Work in Hot and Humid Environments".

Friday, December 10

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF MECHANICAL ENGINEERS, APPLIED MECHANICS GROUP (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—General Review of "Fluid Flow through Granular Beds" (Discussion based on papers by Dr. H. E. Rose and Dr. A. M. A. Rizk).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. T. W. F. Brown: "British Marine Gas Turbines" (Parsons Memorial Lecture).

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Brigadier R. A. Bagnold, F.R.S.: "Model Scale Experiments on Waves and Beaches".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. E. K. Rideal, F.R.S.: "The Emission of Light in Chemical Reactions".

Saturday, December 11

BRITISH PSYCHOLOGICAL SOCIETY (in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Prof. G. Humphrey: "Some Problems in the Modern Theory of Learning".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 2.30 p.m.—Mr. Percy Edwards: "British Wild Birds and their Voices" (Pictures and Voices).•

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR LECTURER IN PHYSICS at the Ministry of Supply School of Electronics—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs., quoting 5/138/JFA (December 11).

LECTURER (Grade IIc) IN CHEMISTRY—The Secretary, The University, Edmund Street, Birmingham 3 (December 11).

DEPUTY LABORATORY STEWARD FOR THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Liverpool (December 11).

ELECTRONIC PHYSICISTS and ELECTRONIC ENGINEERS (in the Senior Scientific Officer, Scientific Officer, Experimental Officer and Assistant Experimental Officer grades) in Ministry of Supply research and development establishments mainly in Hampshire, Worcestershire and Kent—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.161/48A (December 11).

LABORATORY STEWARD to take charge of the maintenance of Physics and Chemistry Laboratories—The Warden, Goldsmiths' College, New Cross, London, S.E.14 (December 11).

SENIOR SCIENTIFIC OFFICERS, SCIENTIFIC OFFICERS, EXPERIMENTAL OFFICERS, ASSISTANT EXPERIMENTAL OFFICERS and SCIENTIFIC ASSISTANTS in the Air Ministry Soil Testing Laboratory under the Directorate General of Works in London or the Provinces—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.487/48 (December 13).

DEPUTY SURVEY OFFICER at the Coal Survey Laboratory, Cardiff—The National Coal Board, Establishment (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, quoting TT/103 (December 13).

TEACHER OF CHEMISTRY for matriculation and intermediate science classes—The Principal, Norwood Technical College, Knight's Hill, London, S.E.27 (December 13).

ASSISTANT LECTURER IN PHILOSOPHY—The Registrar, The University, Leeds 2 (December 13).

ASSISTANT WARDEN for duty at Juniper Hall Field Centre, near Dorking—The Director, Council for the Promotion of Field Studies, 10 Exhibition Road, London, S.W.7 (December 14).

CROMBIE-ROSS CHAIR OF MENTAL HEALTH—The Secretary, The University, Aberdeen (December 15).

LECTURER IN MECHANICAL ENGINEERING, a LECTURER IN CIVIL ENGINEERING, a LECTURER IN ELECTRICAL ENGINEERING, and a LECTURER IN AUTOMOBILE ENGINEERING, at the Technical Institute, Yaba, near Lagos—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1 (December 18).

CANDIDATES for two posts in the Directorate of Scientific Control to carry out operational research—The National Coal Board, Establishment (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, quoting TT/110 (December 20).

DEPUTY CITY BACTERIOLOGIST—The Town Clerk, Municipal Buildings, Dale Street, Liverpool 2, endorsed 'Deputy City Bacteriologist' (December 20).

KEEPER OF ART, a KEEPER OF ANTIQUITIES, a KEEPER OF GEOLOGY, a SCHOOLS SERVICE ORGANISER, and an ASSISTANT KEEPER OF ART—The Director, Museum and Art Gallery, New Walk, Leicester (December 29).

CHEMISTS, CHEMICAL ENGINEERS and FUEL TECHNOLOGISTS at the Dominion Laboratory, Wellington—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (December 30).

CANDIDATES (Experimental Officer and Assistant Experimental Officer grades) for indexing and abstracting literature and official reports and supplying research workers with information—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.381/48A (December 30).

PROFESSOR OF BOTANY—The Secretary and Registrar, University College of North Wales, Bangor (December 31).

NEW ZEALAND RESEARCH FELLOWSHIP—Research Applications, British Federation of University Women, 17a King's Road, London, S.W.3 (January 1).

ECONOMIC BOTANIST IN THE DEPARTMENT OF AGRICULTURE, Fiji—The Director-General of Recruitment, Colonial Office, Sanctuary Buildings, London, S.W.1.

CANDIDATE with a special interest in and general knowledge of the Rhynchota to undertake determinations and possibly later a certain amount of systematic revisionary work in that order of insects—The Director, Commonwealth Institute of Entomology, 41 Queen's Gate, London, S.W.7.

DEPARTMENTAL DEMONSTRATOR IN PHYSICAL ANTHROPOLOGY—The Professor, Department of Human Anatomy, The University, Oxford.

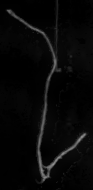
LECTURER IN HORTICULTURE at the Kent Farm Institute, Sittingbourne—The County Education Officer, Springfield, Maidstone.

ASSISTANT MANAGER (Production), a TECHNICAL RECORDS OFFICER, and a WORKS ENGINEER (Maintenance), IN THE DEPARTMENT OF ATOMIC ENERGY at Windscale Works, Sellafield, Cumberland—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

ABSTRACTORS (male and female)—The Secretary, British Shipbuilding Research Association, 5 Chesterfield Gardens, London, W.1.

EXPERIENCED METALLURGIST for the application of research results to industrial practice—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

TECHNICIAN (Grade II) IN THE DEPARTMENT OF CIVIL ENGINEERING—The Secretary, University College, Gower Street, London, W.C.1, quoting 'Civil Engineering/1'.

VISITING DEMONSTRATOR IN BACTERIOLOGY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

METEOROLOGIST for Directorate of Civil Aviation, Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.22047/3E.